THE

ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
Electrical Nomenclature	513
The Mediæval and Modern in Electric Lighting	515
Telegraphic Communication in the West Indies	516
Discussion on the Most Economical Age of Incandescent Lamps	518
Prof. Ewing's Experimental Dynamo (*illustrated*)	520
Facts and Figures on Electrolytic Chlorine and Soda (*continued*)	521
Dynamo Graphics (*illustrated*)	522
Principles of Primary Batteries (*illustrated*)	523
Fault Finding in Conductors	525
Prime Movers for Small Power Generating Plants	526
The Lamp Situation in America	527
Proceedings of Societies:—	
Some Applications of Electricity to Chemistry	528
Legal:—Elgood *v.* General Electric Power and Traction Co.	529
Obituary.—Notes	529
Contracts Open and Closed.—Business Notices, &c.	531
City Notes:—Submarine Cables Trust	532
West Coast of America Telegraph Company	532
Indo-European Telegraph Company	533
Elmore's Patent Copper Depositing Company	533
Elmore's Wire Manufacturing Company	534
Elmore's German and Austro-Hungarian Metal Company	534
Brazilian Submarine Telegraph Company	536
African Trans-Continental Telegraph Company	536
Yorkshire House-to-House Electricity Company	537
Great Northern Telegraph Company.—Traffic Receipts	537
Share List of Electrical Companies	538
Progress in Electric Measurement (*illustrated*)	539
New Patents.—Abstracts of Published Specifications	541
Correspondence:—Single-Phase Alternating Current Motors	542
Railway Train Lighting	543
The Attractive Properties of a Current	543
Influence of the Frequency on the Physiological Effects of Alternating Currents	543
Relative Safety or Danger of Electric Light Current	543
Notes on Electro-Tanning	544

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ELECTRICAL NOMENCLATURE.

M. E. HOSPITALIER has a very concisely written article in *L'Industrie Electrique*, in which the attempt is made to arrive at a definite nomenclature for electrical quantities, by suggesting certain rules to be adopted by those who are to discuss them at the coming congress at Chicago. In this he follows the excellent example of the American Institute of Electrical Engineers, who have prepared a provisional programme a long time before the International Convention, so that the various points can be understood and formulated before actually submitting them for decision. This is an example which might well be widely followed as a means of economising the energy, patience, and time, of all conventions.

Following the natural order of the C.G.S. system, M. Hospitalier first condemns the term "absolute" as applied to it, on the grounds that there are several *absolute* systems of which the C.G.S. happens to be one; *i.e.*, that adopted by the International Congress of Electricians in 1881. With regard to the actual names chosen for the units, these, he says, have been left to the caprice and fancy of their authors, so that it is not rare to see several definitions of one and the same quantity or unit, and often the same name applied to several quantities or units which are altogether different from one another. The hope is held out that the same thing may be done for physics which was done a century ago by Guyton de Morveau for chemistry; and it would appear that the moment has come for a congress to define the general rules which ought to have precedence in the establishment of names and definitions of magnitudes and their units. If these rules could obtain the sanction of the International Congress they would greatly simplify the task of future conventions; for it would be sufficient to apply them rigorously for the creation of new magnitudes, as new units are rendered necessary by the continual progress of science and industry. It is not pretended by M. Hospitalier that he can formulate fixed principles or make absolute rules, but he aims rather at developing a broad outline, leaving to the learned *savants* the matters of detail. Every distinct physical quantity is to be clearly defined, as regards:—(1) Its special name; (2) Its international symbol; (3) Its equation as a function of the fundamental quantities and other derived magnitudes; (4) A C.G.S. unit—a special name with abbreviations; (5) Its relation to other units, practical, &c.

When, by its nature, the physical quantity requires an authentic and actual standard of comparison, the following additions to the above are necessary; (6) A fundamental standard for scientific research, and works of great precision; (7) A practical standard for the purposes of industry.

The writer then gives arguments showing why these conditions should be followed in the genesis of terms. It is important to have a special name, and one only, for each

distinct physical quantity, but it is not always essential that this name should be formed of one single word; and the proposal is made that, where it is advantageous, rules might be adopted for the formation of new terms, if practice requires them. In the case of physical quantities allied respectively to length, surface, or volume, it is suggested that the qualifications, "linear," "superficial," or "cubical," should be prefixed to the specific term, to indicate that a new quantity is under discussion. For example, the "*linear capacity*" of a submarine cable is the quotient of its capacity by its length, and is measured in microfarads per kilomètre; while the "*linear insulation*" of a line, which is the product of its insulation resistance and its length, will be measured in megohms per kilomètre. The object of this seems to be the elimination, for the time being, of the idea of a second unit—the kilomètre—when defining the simpler relations which hold between physical quantities. The energy stored in a dielectric, or dissipated in a magnet by hysteresis, is proportional to the *volume* of the substance considered, and to a certain factor to which the name "*specific energy*" has been given. If w and v denote the specific energy and volume respectively, the equation of definition is

$$\frac{w}{v}.$$

According to the rule which M. Hospitalier has proposed, the specific energy would be termed the "volumetric" or "cubic" energy.

It is supposed to be understood that these rules are to be applied only in the cases in which it is necessary to create new words. For example, the quotient of the *mass* of a body by its *volume* will retain the name "*density*," instead of being called a "volumetric mass," or a "*masse cubique*."

The attempt of English physicists to crowd into one term all the involved physical quantities and units is regarded as fantastic. Only physical quantities are to enter into the definition of physical quantities. Thus, *speed* as a "length per second;" *power* as "work per second;" *specific resistance* as "resistance per cubic centimetre;" *magnetic induction* as the "number of lines of force per square centimetre," &c., are denounced by M. Hospitalier as illogical.

To facilitate the reading of equations, each physical quantity is to have assigned to it a definite symbol, to be adopted once and for all. In order to reduce their number, like symbols may be adopted for physical quantities of the same dimensions. The systematic employment of the different orders of letters, italics, Greek, &c., has already been recommended by the Frankfort Congress of 1891; it remains to establish this internationally.

In any coherent system of physical nomenclature, each quantity should be derived from those previously laid down; each should take the form of a simple equation, an algebraical expression, which would constitute the equation of definition. It would be easy to deduce from this an equation of corresponding dimensions, by a simple interchange of terms and quantities.

The C.G.S. unit of a derived physical quantity is deduced from its dimensional equation by expressing all terms in C.G.S. units. This is a rule of universal application, and there is reason why it should be insisted upon. But it would be of advantage, for practical purposes, to give special names to some of these units which are of frequent use—certain magnetic units, in particular, as has been already done for the *erg* and the *dyne*. When a unit is compounded of two others, the general rule of formation consists in linking the component names by a hyphen, when they are to be multiplied; and to separate them by the word "*per*" when the two units are in the form of a fraction. Thus we have: ampère-hour, watt-hour, metre *per* second, watts *per* candle-power. If the wish expressed by the Frankfort Congress is followed, the abbreviation of C.G.S. units will be indicated in Roman characters, taking the initial letter or a small number of the first letters of the name.

The practical unit adopted for the measure of a physical magnitude will be a multiple, or a decimal sub-multiple, of the corresponding C.G.S. unit. The abbreviation of practical units will be formed and written according to the same rules as those formulated above for the C.G.S. units.

Every fundamental standard of a physical quantity should be either an exact copy, or a copy as exact as possible, of the accepted magnitude, or defined with sufficient precision to enable it to be realised without appreciable error or ambiguity. In this regard, the Congress of Electricians at Chicago will have to define two important standards: (1) A standard of resistance; (2) A standard of E.M.F. In order to avoid confusion with corresponding standards proposed by previous Conventions, M. Hospitalier suggests that each of the standards should carry a characteristic *épithète* of distinction. Thus: Chicago ohm; ohm_{98}; $ohm_{106,3}$; &c. The name "ohm" (*sans épithète*) to be reserved to the C.G.S. system, defined as equal to 10^9 C.G.S. units.

It is difficult for a Congress to decide upon practical standards of magnitude of physical quantities. The electrodynamic balance of Lord Kelvin, and the ampère-standard of M. Pellat, constitute the verifying standards for the measurement of current. A certain number of voltaic combinations give electromotive forces sufficiently constant, and of suitable magnitude, for a standard; their adoption must depend more or less upon questions of detail. On this point, M. Hospitalier expresses little hope of a universal understanding; but he emphatically signalises the importance of an international practical standard.

In the establishment of a scientific and rational nomenclature, too much time should not be spent in the mere designations and titles of the quantities to be expressed. What virtue is there in naming a magnitude? The credit due to a man for this is no greater than that ascribable to an unfortunate curate for his weekly denomination of the local cherubs. It is quite a different matter to draw up definitions and to formulate rules for future application. This done, the mere titles will take care of themselves. M. Hospitalier's suggestions seem to us to imply a much more extended use of the metric system than is at present adopted in practical quarters; so that if such terms as "*capacité linéaire*" and "*isolement linéaire*" find favour, and universally displace "mfds. per n.m.," and "megs. per n.m.," we shall have to reduce our *nauts* to kilometres, or work with elastic cables. If the Chicago Congress will establish the practical use of the metric system among electricians, they will not have met in vain.

THE MEDIÆVAL AND MODERN IN ELECTRIC LIGHTING.

The oldest venture of any importance in electric lighting, having corporate ownership, is that of Bradford. If it be true that "happy is the country which possesses no history," that scheme is blessed of which little has been heard, because of its very success and freedom from the ills scribes are so prone to chronicle. Unhappily, it is not so with the electric lighting affairs of the woollen capital; the very boldness with which it entered upon the field in what may be regarded as the middle ages of the development of the industry has caused its annals to be far from scanty. It will be remembered that when the Town Council determined to undertake the construction and management of the necessary works, and retain the supply in their own hands, Mr. Shoolbred was appointed consulting engineer, with powers to recommend a suitable system of distribution, to design the works, and prepare plans for their execution. Nothing can be more unfair than to criticise long-standing work by the light of present knowledge, and whatever may be said in this direction should bear upon the proposals at present before the Council, and touch very leniently upon the more venerable portion of the enterprise. Bearing in mind the date of his report, it may be conceded that Mr. Shoolbred advised to the best of his ability in the then position of the industry, when he put forward recommendations that a two-wire continuous current direct supply system should be adopted for the area in the centre of Bradford, with which his instructions were to deal.

Curiously enough, about the same time, Mr. Shoolbred was engaged in advising the Liverpool Corporation upon the proposals of the local supply company in its attempt to procure a license from the Board of Trade.

It is out of the question to say how far the views expressed by their consultant may have influenced the Corporation in bringing pressure to bear upon the company to adopt a certain system, but it is the case that Liverpool up to very recently was the victim of another two-wire system. The results in Liverpool and Bradford from the consumers' point of view were very similar. A fairly constant supply was given, but the irregularities of voltage on the outskirts of the supplied district caused considerable grumbling on the part of the more exacting consumers. In the case of the Liverpool Company, whatever went on at board meetings was buried in the bosoms of the directors and engineer, although the gradual conversion of the network to a three-wire system enables one to judge what must have taken place behind the scenes. At a much later date what must the Brighton Corporation do but follow the lead of the two towns mentioned, and in their corporate wisdom pin their faith to another two-wire scheme. As was to be expected they, like Liverpool, did not feel "pleased with their lot, contented and happy with what they had got," but must "sit sighing for what they had not," to wit, a third wire to make merry with the two on whose good graces they had previously relied.

To return to Bradford, when we described the system nearly twelve months ago, we said that "Local bodies are, to a great extent, in the hands of their technical advisers," and this question is of greater importance to-day to the town of which we are speaking as well as to many others, than it was at the time when this was written. The borough, three miles by five, has only a comparatively small central area scheduled for supply, and the station is close to the boundary at the north-east corner. Owing to the demand increasing in the compulsory area, and the necessity for increased facilities for reaching untouched districts, the scheme of extension has pressed for consideration. It will be seen by the map we published in June, 1892, that the greatest distance from the central station reached by the mains is insignificant compared with what must be met if the intention is carried out of providing a supply to the whole Borough, and to Allerton and other outlying townships in addition. It would be useless to attempt to tinker with a two-wire system to-day, when its capabilities have been so fully tested, and it has disappointed even its most sanguine supporters in the instances mentioned. Yet Alderman Priestman, speaking for the Bradford Electricity Committee, and by the advice of Mr. Shoolbred, recommends the extension of the two-wire system in use, mentioning that to alter this would involve beginning afresh with a three-wire network. The idea seems to be to double the present two-wire mains, and so stave off the evil day a little longer, when the whole question must receive well considered treatment. For the work in view it is estimated that the cost of continuing the two-wire mains would be £9,630, while the alterations and additions to enable the three-wire principle to get a footing would be £5,970. To still further help the progressives, the working costs in the two cases would be different by £424 per annum, a clear gain by adopting the third wire.

The Corporation electrical engineer, Mr. Sydney Baynes, is a strong advocate for progressive views, and it will be the hope of all well-wishers of municipal enterprise that he may gain the day. If one moral more than another be culled from the annals of Bradford lighting, it is this: The resident engineer to a corporation must, if he be competent to perform his duties, be a better judge of the system to adopt for extensions than an outside expert of whatever eminence. The former is constantly in touch with the local requirements, and, moreover, is the scapegoat of the Corporation if complaints are the rule. The consulting engineer has his place in the first instance, and as an advisory expert afterwards, but the onus rests with the permanent officer, and fair play to him is a jewel.

The New Aron Meter.

In this issue, for the first time, the long talked of Reckenzaun meter is described, and the steps leading up to the new pattern of Aron meter are briefly mentioned. We call what the makers are pleased to term "the General meter"—no doubt in the hope that it will become a general meter some day—a new Aron meter, as being the title which will appeal to the larger number of our readers, and indicate the species to which the new arrival belongs. The association of the General Electric Company with the Aron meter is of old standing, and while they are giving indications of a proneness to cast off the old love for a new, the new seems likely to worthily uphold the names of its creators. A meter is nothing if not commercial, and Mr. Reckenzaun's inventive talents have been fully supported by Mr. Binswanger in the actual production of a practical form of meter, which, having placed very fully before those who are competent to form an opinion, we leave it to them to do so, and to the lapse of time to prove or disprove the correctness of such conclusions.

TELEGRAPHIC COMMUNICATION IN THE WEST INDIES.

How Trade and Intercourse may most Successfully be Restricted within the Narrowest Limits.

By Dr. R. B. ANDERSON.

After eighteen years' residence in the West Indies, during the greater part of which time I have been a landed proprietor, anxious to see my land increase in value, and to see my adopted country rise to the wealth and importance to which its natural advantages entitle it, I now address myself to your readers and to you, because one of the relations of the subject is especially your own, the deficiency in this matter, of telegraphic communication, as of other means of intercourse with the rest of the world, and the great room for expansions in this, as in other directions.

All publicity is useful and it is a treat to be able to come forth of that "jungle of red tape" to the light of a larger and fuller dispensation of reason through your columns.

Some of your readers, though probably not many, know that the trade with the West Indies is still of importance, though trifling in proportion to its former magnitude; but I doubt if anyone in this country realises the enormous scope for development that those colonies would afford if the necessary attention were directed to them, and proper methods were adopted.

They are commonly regarded as small and unimportant, and, if I may be pardoned a vulgarism, as practically "used up." Compared with the enormous scale of our large self-governing colonies—and with their own past—both these suppositions at first sight seem justified, but, in fact, they are totally unfounded. Including British Guiana and British Honduras, the present population of the West Indies is about one million six hundred and fifty thousand; the present annual revenue is two and a quarter million pounds, and the present annual production in exports nine and a half million pounds. Truly insignificant beside the corresponding figures for Canada, Australia, Africa, or India! But the whole area is a hundred and twenty-four thousand square miles. Barbados maintains a population of eleven hundred to the square mile, and exports off her limited area per head to the value of seven pounds, or equal to twelve pounds per square acre, besides producing the supplementary food supply for this teeming population.

Take two-thirds of this proportion of population and apply it to two-thirds of the area I have given, and the result will be found to be rather startling. According to such a calculation, the West Indies can maintain a population of thirty millions in the greatest comfort; can, if thus peopled, raise a public revenue of fifty-five million pounds per annum; and produce annually, in exports, to the value of over six hundred million pounds. All that is required is capital and labour, and organisation—apparently, none of them, as yet, within reasonable expectation.

When I first made these calculations I feared I had possibly taken too high an average of cultivable area; but, on the most careful enquiry, I have on all sides been assured in regard to each colony that two-thirds is certainly less than the proportion of land that is fertile and suitable for cultivation, whilst much of it, as compared with the land of Barbados, has all the superiority of practically virgin soil. The land is there, and some natural advantages not to be found, combined with such wealth of productiveness, elsewhere in the world. One of these advantages is the proximity of water-carriage throughout the greater part of this area; another is the fact that, almost throughout, the heavier traffic is towards the sea, and on a descending incline. Another is the proximity to the best markets in England, the United States, and Canada. These colonies are nearer to England than any other of her colonies that give similar products, and, in most cases, they are not more than half the distance of possible rivals. America has provinces that might compete with the West Indies in her own markets and in those of Canada; but in such a competition it is probable that water carriage, with so great facilities will, when properly managed, maintain the advantage for cheapness over land carriage; and the days may not now be so very distant when, in the markets of Canada, that advantage will be increased by effect being given to the natural preference for dealing with our fellow subjects on terms of permanent mutual concession, and mutual benefit, security, and interdependence. At least as to the English market, the natural advantage is great and definite, if it ever come to be expressed in the terms of its true value in pounds, shillings, and pence. So expressed, it means that West Indian produce can be put on the English markets at a fraction over half the freight at which the produce of *other tropical countries* can be brought to England; and it should mean that English capitalists, English colonists, our fellow subjects of those colonies, English visitors to them as tourist and health resorts, and all who have, or wish to acquire, an interest in them, should be able to travel to and from them and even to write to each other from the colony to the mother country, or *vice versa*, at the same proportion, as to the time occupied in the voyage, and as to the cost of the voyage or of postage as I have alluded to,—that is a fraction over the half both as to time and as to expense.

Probably the same rule as to expense would apply, under favourable conditions, to telegraphic intercommunication, and certainly a great and rapid development of that Province would bring about a proportionate development of telegraphic and electric business.

For such a development not only capital and labour, but organisation is required, whereas at present organisation generally takes the form of organised resistance to all advance and all development; and where there is no organised resistance, the passive maintenance of the *status in quo* is observed with deadly pertinacity. In this it will be seen that I refer chiefly, though not entirely, to the Government.

The mountain consists of its aggregate of atoms, and if the West Indies are ever to be fully developed, that process, as all others, must be one of growth, and have its early stages and its small beginnings; and it is in these stages that the impediments I speak of are so telling and so injurious.

Many of these at first sight seem natural obstacles, and seem and are said to be insuperable. But on examination it will be found with nearly all, if not with all of them, either that their importance is over estimated, or that they may be overcome by the proper measures, or are not natural obstacles at all, but have been placed and are maintained where they are by human stupidity; sometimes, it would almost appear, by sheer human perversity.

Amongst these obstacles, undoubtedly one of the chief is the very high rates of tariff that prevail in all kinds of travelling, transport, and communication. This applies to passenger fares between England and the West Indies, and the fares between the respective West Indian Colonies—to the freight of goods, to postal and telegraphic communication. And every representation as to the prohibitive influence of these rates is met by the apparently unanswerable objection that owing to the comparatively small amount of business to be done in each respect, there would be no probability by reducing these rates to so extend business as to recoup the loss on each item by the greater number of items, and the larger amount of business to be done. Nothing but the test of the actual attempt can put this objection to the proof; and it is not to be wondered at that, in the absence of competition, those who are in possession of the field prefer not to make a hazardous experiment. But there are ways in which tentative experiments can be made, and there are respects in which the people of those countries have a right to demand that they should be made. Other not less serious difficulties are placed in the way of development by arrangements that could easily be amended, and conditions that could easily be improved, by the application of the smallest modicum of ingenuity or of common sense; and it is especially the possibility of such tentative experiments, and the possibility of removing these difficulties of the lesser magnitude, that I wish to consider in these articles. And if I can show some instances in point, I at least indicate sufficiently the primary requirements for increasing business of all kinds, including telegraphic and electric business, in the West Indies.

One of the respects in which the value of the West Indies is totally underestimated, is that of a winter and health resort for the people of this country; and in some instances one colony or island has special advantages or conveniences as a health or pleasure resort for visitors from other islands.

The British and West Indian Alliance, of which I am a vice-president, has now, for some time, been in communication with Messrs. Thos. Cook & Son as to organising a system of personally-conducted winter tours to and through the West Indies. All such tours would follow a prescribed course; but tourists would be able to leave the party, should they prefer to do so, and to lengthen their stay in one or other island, according to their own predilection; and no doubt some of the larger islands, and especially Jamaica, would attract great numbers of these more permanent visitors. But amongst the smaller islands there is none possessing greater natural advantages than Tobago, as a resort for visitors, whether from England or from neighbouring colonies, and especially from Trinidad, to which island it is now annexed, forming a single colony. These advantages consist in a particularly bracing and renovating air, an almost continuous sea breeze, and, during the cool months, from November to May, a very cool and comfortable temperature (for the tropics, of course), ranging from 65° F. to 85° F., and seldom reaching 90°, whereas we all know that the summer heat of this country may rise considerably over that point. I will not dwell here on many other advantages that Tobago, amongst other West Indian colonies, offers. A tour of cricketers and sportsmen is being arranged; and the best thing your readers can do is to come and find out next winter what these advantages are; since all your electrical science fails as yet to relieve us of the fogs that render life a burden, and to illuminate the thick darkness that they bring with them there, I may merely mention, as inducements, besides cricket, lawn tennis, rifle matches, billiard matches and boating, and by way of a special attraction, the electric light and electric tramways. These, with constant summer, bright, but not cloudless skies, horse exercise, sea bathing, fishing and shooting, may suffice to pass the time agreeably for three or four months. Such tours are at present being considered and arranged for, and this is one of the aspects in which, most profitably to themselves and to this country, the West Indies might begin to be developed.

And now comes in most effectively, and from several sides at once, "the way *not* to do it," and from the outset we are met by those more or less real difficulties that I have mentioned. Taking my experience in Tobago, and what I have said of the value of Tobago as a health and pleasure resort, I can, I think, well illustrate my meaning.

Tobago is one of the very few parts of the British possessions that are without telegraphic communication, and, so far, all efforts to secure that advantage have been frustrated either by active opposition, or by that passive indifference that characterises the Governments of those colonies—unless the governor has some personal motive, either to obtain credit for a new idea, or to take up and press forward a particular measure.

The distance of Tobago from Trinidad direct is only 18 miles, so that it will at once be seen that the expense of connecting that island with the system of the West India and Panama Cable Company could not be very great.

The measure has been brought forward on several occasions; once, before I went to Tobago, I believe about the year 1870, an opportunity occurred of securing this advantage for an annual subsidy of £500, but this was successfully opposed by the local mercantile and shipping interests; and, as the Government was then representative, this course was at least within the rights of the Legislative Assembly, however questionable its wisdom. But that system of government was abolished, as it was said, because of its class leanings and the constant difficulties thrown in the way of general improvement. It would, therefore, have been natural to expect that when the Crown succeeded in obtaining the control, its power would be exerted to institute proper arrangements in a matter so important to all progress according to modern ideas. Not only has this not been the case, but, as I am in a position to prove, very unnecessary obstacles have been thrown it the way of this important measure; whilst help that could easily have been afforded, and that I think I could show ought, in Imperial as well as local interests, to have been unhesitatingly afforded has been, and is being, withheld by this paternal Government.

In 1891, being much in Trinidad, and being a member of the Financial Board of Tobago, the body which in that island votes and raises the revenue of the Crown for local purposes, I broached the subject to Mr. Hay, then Commissioner of the Government of Tobago. In reply, I was informed that, on enquiry, the West India and Panama Cable Company had given, as the best terms on which they could lay down and work a cable from Trinidad to Tobago, a subsidy of £1,600 per annum for ten years. This was, I knew, beyond what Tobago would be willing to pay, and would, in fact, be prohibitive. In Trinidad I learned, to my surprise, that far from these being the only terms mentioned by the company, there had been other communications with them, and that the company had stated, through their superintendent in St. Thomas, and on the estimate of Sir Samuel Canning, the company's engineer, that a cable might be laid between the nearest suitable points of land of the two islands, consisting of twenty-five knots, partly of intermediate and partly of shore-end kinds, at a cost of £5,000; whilst an electrician of the company, with great experience of the formation of the sea bottom, had stated that deep-sea cable might be used, with about six or seven miles of shore-end cable, and thus the cost be reduced to £3,500.

On this subject, Mr. Tucker, who is deeply interested in Tobago, and myself, obtained an interview with the Governor, Sir W. Robinson; and I cannot, perhaps, do better than insert two letters that passed on the subject—one from the Colonial Secretary, and one which I addressed to the Governor.

That from the Colonial Secretary is as follows:—

"Colonial Secretary's Office, Trinidad,
"*October 4th*, 1890.

"Sir,—With reference to the interview which you had with the Governor yesterday, on the subject of the establishment of telegraphic communication to Tobago, I am directed to inform you that no offer or correspondence has been received from the telegraph company in regard to the laying of a cable since the one in August, 1889, when an annual subsidy of £1,600 a-year, for 10 years, was required.—I am, Sir, your obedient servant,

"(Signed) H. W. CHANTRELL,
"*Acting Colonial Secretary.*

"To Dr. R. B. Anderson."

My own letter was written on the 7th, but, from the postscript, it appears Mr. Chantrell's did not reach me till the same day. My letter was as follows:—

"To his Excellency,
"Sir William Robinson, K.C.M.G., Governor, &c.

"Sir,—1. When I called on Friday morning I had not with me the dates of the letters I spoke of, and which afforded to the Government the information I was so pleased to find had been furnished to them.

"2. I mentioned that Mr. Hay stated, as the *only* terms he was aware of, that the West India and Panama Cable Company would lay and work a cable for 10 years at an annual subsidy of £1,600.

"3. This was, I think, in July, 1890.

"4. It was on July 18th, 1889, that Mr. Miller, the company's superintendent in Trinidad, having ascertained through the General Superintendent at St. Thomas's, wrote to the Colonial Secretary that Sir Samuel Canning estimated that the cable from Toco to Tobago would require 25 knots of shore-end and intermediate kinds of cable, and added that the company would bring it out, and hand it over in working order, with a guarantee, for £5,000. The Government was again referred to this information on August 29th, 1890, so that there is no change of intention on the part of the company.

"5. Mr. Miller thinks the Morse system of telegraphing, requiring clerks at £80 or £100 per annum could be used, or even the telephone be applied, requiring clerks less instructed and at a less salary.

"6. He also says Mr. Obrien, the company's electrician, thinks some deep sea line could be used instead of intermediate, so as to reduce the cost of laying to £3,500.

"7. Tobago could, and I believe would, gladly bear the expense of laying the cable and maintaining her end, and I beg, on behalf of the Planter's Club, to ask your Excellency to be good enough to communicate to Mr. Hay *the assurance that you gave me*, that in case of the £5,0.0 being voted, you would be able to arrange for the amount to be available, as well as to take such other steps as may be requisite to bring about as speedily as possible so essential an improve-

ment in the condition and prospects of Tobago, as the uniting her to the rest of the world by cable would amount to.

"8. I have seen Mr. Fenwick (one of the unofficial members of the Council of the Colony of Trinidad and Tobago) on the subject of the land line to Toco (the point of Trinidad nearest to Tobago). He did not, nor did I exactly ask him to pledge himself to support it or to move it; but I think I may feel that he regards it as presenting considerable differences from the project of the land line to Mayaro (a point a considerable distance from Toco, and not available for the Tobago connection) which he did oppose, and this difference consists, as I understood him, not only in the local value and use being greater, but from the greater importance of its relations to Imperial defence, by extending the sphere of observation, and means of communication to the south-east coast of Tobago, or indeed to the whole Island and a large sweep of sea on each side.

"9. Subject to correction from your Excellency, I suppose the proper course would be for the Financial Board (of Tobago) to vote the necessary amounts for laying the cable and working their end, and then for them to address the Legislative Council, asking that Trinidad should, on her own side, lay the land line from Port of Spain to Toco and maintain the Toco station.

"10. May I ask for the favour of an early reply, as I am going to Tobago, and should be glad to have it, so that before returning here I might use it to aid in the necessary steps at Tobago.—I have the honour to be, Sir, your obedient servant, R. B. Anderson."

"P.S.—Since writing the above I am in receipt of to-day's communication on the subject.

"I cannot at all understand either the £1,600 a year being asked, or the communication through Mr. Miller being left out of consideration. The method and terms mentioned by Mr. Miller bring the project within the means of Tobago, while the £1,600 a year render it quite out of the question."

Of this correspondence nothing came, the *status in quo* being, as I have said, pertinaciously maintained; probably from the same reason, or the same want of reason, as led to the deliberate attempt, *vide* Mr. Chantrell's letter, to conceal the very easy terms on which a cable could be laid, and which were concealed until I thus dragged them to light.

Being unwilling to relinquish hope, I wrote to the Tobago Member of the Legistative Council of the colony, to endeavour to secure, by his co-operation, what it is evident the Executive Government could and ought to have done all in their power to promote. This letter is as follows:—

"Macquéripe House, Port of Spain, Trinidad,
"*May* 30*th*, 1891.

"The Hon. John McKillop, M.L.C., &c.,

"1. Sir,—Some time since I was authorised by the Planter's Club to make enquiries as to the possibility of obtaining the extension to Tobago of telegraphic communication. Not only in the same connection, but as an inhabitant of that island, and particularly as a member of the Financial Board, I am still deeply interested in the subject.

"2. The terms of the West India and Panama Cable Company first stated to me, through Mr. Hay, for laying and working the line, were £1,600 per annum for 10 years, which would be prohibitive.

"3. But on further enquiry, it appears that the company would lay a cable for £3,500, and this, with the Tobago land line to Scarboro', say, £500, would cost, at 4 per cent., £200 per annum, and £100 for a sinking fund, and £100 per annum for working expenses, would bring the cost to Tobago to £400 per annum, if Trinidad would meet us with a land line to, and station at, Toco.

"4. Tobago is well fitted for a health resort for Trinidad; and is gradually becoming known and used in that way, so that besides the advantages to the districts the Trinidad land line would pass through, there would be a gradually increasing general advantage to the whole colony; and I have little doubt that Trinidad Members of Council will be willing to sanction a measure of advance and improvement.

"5. But irrespective of these objects, a signal station at Pigeon Hill, at the north-east end of Tobago connected telegraphically, through Scarboro', with Port of Spain and with Georgetown, would greatly extend the means of observation and defence of Trinidad and Demerara, as to the movements of enemies' vessels, and it would seem impossible in any scheme for the defence of these colonies to overlook this consideration, whilst if regard be had to it, there should, it would appear, be a considerable contribution towards it from the special fund for these defensive purposes.

"The fact that a new cable is be to laid shortly between this colony and Demerara would appear to make the present a particularly appropriate time for broaching the subject.

"Mr. Fenwick at first was inclined to oppose such a line, but now, although not at all pledged in its favour, he is willing to consider it from any fresh points of view that may be indicated.

"Taking into consideration the difficulty of your frequently attending meetings of the Council, I have no doubt facilities would be afforded you for bringing up the subject; and remembering how greatly Tobago suffers from the want of telegraphic communication, I feel sure you will, if possible, do so, and do all in your power to supply a want so serious.

"I have, &c.,
(Signed) "R. B. Anderson."

To this Mr. McKillop replied—

"Dear Sir,—I received your interesting letter on Monday morning, and I think that the feasibility of the propositions as to defence is capable of demonstration. I could not, of course, do anything in the matter on Monday, but I shall not lose sight of it.

"I am, dear Sir,
"Yours truly,
"Jno. McKillop."

From this narrative and correspondence, it is, I think, evident that the local executive government not only did nothing to promote, as it was their duty to promote, this essential step for the progress of Tobago; not only that they neglected and are still neglecting the requirements of imperial defence, and refused the aid that should have been furnished in the interests of imperial defence; but that they systematically concealed the cheapness and facility of this most essential improvement.

These facts appear to have an interest for electricians, because all that impedes the due development of business in any direction must injuriously affect all connected with that business. There are other hindrances to, as well as some measures for, the promotion of telegraphic communication in that very interesting and potentially important province, of which I hope to treat in a subsequent article.

DISCUSSION ON "THE MOST ECONOMICAL AGE OF INCANDESCENT LAMPS."

We called attention to the interesting and important nature of Mr. Carl Hering's paper on this subject in our issue for February 3rd last, and later (March 17th), printed it in full. The paper has awakened considerable interest in America, and we now give an abstract of the verbal and communicated discussion which followed its delivery. The full account may be read in the *Electrical Review* (New York), for April 8th.

Prof. B. F. Thomas, whose name is so intimately connected with the celebrated Ohio lamp tests of two or three years back, referred to the importance of the facts which were suggested in Mr. Hering's Chicago paper and which he had now conclusively demonstrated. He pointed out that even in supply stations where current is measured by meter it is to the interest of the station that the lamps should be comparatively frequently renewed, since the current absorbed by a lamp is higher during the first half of its life than the second half. Thus he calculated that a manager who runs a lamp 1,200 instead of 400 hours would lose 12 cents of profit through the diminution in the current consumed. From the curves shown by Mr. Hering it would be seen that difference in cost of lamps has little effect on the total cost of light. It thus matters little which lamp is chosen,

excepting where uniformity of candle-power during the 400 hours is concerned.

Prof. Elihu Thomson wrote that he considered, with Mr. Hering, that the results were theoretical rather than practical. The excellent practical rule was to run the lamps until there was a sensible diminution in light. Whether then to break them was another matter. In certain circumstances it was possible to run them in parts of a system where higher differences of potential exist and thus obtain further use out of them. It still remains desirable to lengthen the life of a lamp provided it has an economical efficiency during that life. Renewal expenses are thereby decreased. There is also something to be said on the score of convenience of long-lived lamps as against those which run down rapidly and require frequent renewal.

Mr. W. D. Weaver's communication is of some importance, since he describes an analytical method of calculating the point of maximum efficiency, based on a different standpoint to that originated by M. O'Keenan. He said :—

The graphical method which Mr. Hering adopts is very interesting, and the curves enable one to easily follow and thoroughly understand the steps that led to results that at first sight are rather startling. In this respect the graphical method is superior to an analytical one, but it has the misfortune in this case of being extremely laborious in application, and lacking in accuracy unless the curves are laid down on a large scale.

An inspection of Prof. Thomas's table, giving the variation of watts with the life of a lamp, shows that the rate is very uniform in the majority of the tests and numerically equal to an increment of ·3 watt per candle-power per 100 hours. The regularity in these cases enables an analytical method of remarkable simplicity to be applied to the solution of the various problems considered graphically by Mr. Hering, the development of which is as follows:

Let T = total cost of 1 C.P. of light for a given number of hours.
y = average hourly cost during the same period.
a = cost of lamps per candle-power.
b = cost of one electrical horse-power per hour delivered at the lamp.
w = initial watts per candle-power.
k = increase of watts per candle-power for each hour of the life of the lamp.
x = hours that the lamp is used.

Assuming that the increase in watts per candle-power is by equal increments for equal increments of the time the lamp is burning, the watts being used at the time x are $w + k\,x$, and the total watts being used at the time x are:

$$\int (w + k\,x)\,d\,x = w\,x + \frac{k\,x^2}{2}.$$

The total cost, including the lamp cost, is therefore

$$T = a + \frac{b\,w\,x}{746} + \frac{b\,k\,x^2}{2 \times 746}.$$

The average cost is

$$y = \frac{T}{x} = \frac{a}{x} + \frac{b\,w}{746} + \frac{b\,k\,x}{2 \times 746},$$

which is a minimum when

$$x = \sqrt{\frac{2\,a \times 746}{b\,k}}.$$

If A is the cost of a 16 C.P. lamp and K the increase of watts per hour for a 16 C.P lamp, the formula becomes

$$x = \sqrt{\frac{1{,}492\,A}{b\,K}}.$$

The value of k from Prof. Thomas's experiments is ·003, and consequently K = ·048; substituting, we have finally for the life, L, or the "smashing point,"

$$L = 176\,\sqrt{\frac{A}{b}}.$$

By substituting the corresponding values of a and b, the minimum values of the life measured from the final curves laid down in the graphical method are at once obtained from this formula, and it is remarkable that such a simple equation can replace a graphical method so unusually involved. The accuracy of the method of course depends upon the assumption in regard to the arithmetical increase of watts with the life of the lamp, but an inspection of Table I. shows that in most cases an error in this respect is less likely to cause a serious error in the final result than the graphical method, unless the scale of the latter is large.

A singular deduction from the formula is that the "smashing point" does not vary with the watt efficiency of the lamp. Consideration, however, shows that the factors of the question of efficiency are merely the relation between the hourly lamp cost at a given time, and the increment of lamp energy at the same time, and as this is independent of the watt efficiency of the lamp, the latter does not enter.

As the most economical life varies directly as the square root of the cost of the lamp and inversely as the square root of the cost of the power, considerable variations in these values will not introduce large ones in the value of L, as the following table shows:

VALUES OF L.

	b = 10 cents.	b = 4 cents.
A = 35 cents	333	510
A = 45 ,, ...	370	580
A = 55 ,, ...	404	650

The formula just deduced is based upon a constant value of K. Where this value varies materially, the following arithmetical method enables the "smashing point" to be determined, and also gives the ordinates of the curve showing the variation of the average cost of the unit light, the same that Mr. Hering constructs graphically.

In the tables below, which are based on lamps A and M, of Prof. Thomas's experiments, the hours the lamp has been used are in column A, and the watts at the end of each 100 hours in column B. The increase for each 100 hours is in column C, and the total increase at the end of a given period in column D. The cost of this increase at 15 cents per 1,000 watt hours is given in column E, and the average cost per 100 hours in column F, while column G gives the corresponding average cost of the lamp per candle-power per hundred hours, the cost of a 16 C.P. lamp being assumed 45 cents. Column H gives the gain per candle-power per hundred hours from the continued use of the lamp, and column I the loss, these quantities being the sums of the values in columns F and G, and corresponding to the ordinates of Mr. Hering's curve C.

Referring to the first table, it will be seen that at 300 hours the average cost of the increased watts required to maintain the unit length is ·8 cent per 100 hours, while an average of ·94 cent is saved by continuing the use of the lamp; at the end of 400 hours, however, these quantities are 1·031 and ·7 respectively, showing that the cost of the increased power has become greater than the saving from the continued use of the lamp. The exact time when the average increased power cost is equal to the average lamp cost is the "smashing point," and may be determined approximately by a proportion between the quantities for 300 and 400 hours.

The following formula enables the quantities in column D to be quickly calculated:

$$D = (n\,a + (n-1)\,b + (n-2)\,c + d) - \frac{a + b + c + d, \&c.}{2}$$

where n = the hours in hundreds and a, b, c, d, &c., the values for 100, 200, 300, 400, &c., hours from column C.

LAMP A.

A	B	C	D	E	F	G	H	I	
0	3·9	0	0	0	0	0	...	...	Minimum at 324 hours.
100	4·3	·4	·2	·3	·3	2·81	2·51	...	
200	4·6	·3	·75	1·125	·56	1·40	·84	...	
300	4·9	·3	1·6	2·40	0·80	·94	·14	...	
400	5·2	·3	2·75	4·125	1·03	·70	...	·33	
500	5·5	·3	4·2	6 30	1 26	·56	...	·70	
600	5·8	·3	5·95	8·925	1·48	·46	...	1 02	
700	6·1	·3	8·	12·	1·71	·40	...	1·31	
800	6 4	·3	10·35	15·52	1·94	·35	...	1·59	
900	6·7	·3	13·0	19·5	2·18	·31	...	1 87	
1,000	6·8	·1	15·85	23·77	2·37	·28	...	2·09	
1,100	7·0	·2	18·85	28·27	2·57	·23	...	2·32	
1,200	7·1	·1	22 50	33 75	2·82	·25	...	2·59	

LAMP M.

A	B	C	D	E	F	G	H	I	
0	4·8	0	0	0	0	...	...	...	Minimum at 680 hours.
100	4·7	−1	−·05	−·075	−·075	2·81	2·88	...	
200	4·7	·0	−·15	−·225	−·112	1·40	1 47	...	
300	4·8	·1	·05	·075	·025	·94	91	...	
400	4·9	·1	·2	·3	075	·70	·62	...	
500	5·1	·2	·5	·75	·15	·56	·41	...	
600	5·5	·4	1·1	1·65	·276	·46	·18	...	
700	5 8	·3	2 05	3 075	·44	40	...	·04	
800	5·9	·1	3·1	4·65	58	·35	...	·23	
900	6·1	·2	4·5	6·75	·75	·31	..	·44	
1,000	6·1	·0	5·9	8·85	88	·28	...	·60	

Mr. Hering thought that Mr. Weaver's formula was very interesting and valuable, but said he had not had time to examine it carefully. At the two ends of the curve it was not correct, but that was unimportant, as it was correct at the minimum point. He thought, however, that the characteristics of the curves for different lamps would be lost and would probably be parallel. He maintained that his own method was not graphic but arithmetical, and thought a curve might probably be calculated in 10 or 15 minutes. The final result was given graphically because it showed much more than a column of figures would. He considered that Mr. Weaver's second method involved more calculations than his own; though he was prepared to admit that since there was no need of great accuracy in determining the best

age, the purely arithmetical method might after all be the simplest, especially when the data is not given in as convenient a form as in Prof. Thomas's paper.

Mr. G. Hill discussed the matter from the point of view of how the renewal of lamps was to be carried on practically. He thought that a new element should be introduced into Mr. Hering's curves, viz., the expense of the lamp collector. Another point was that it would be necessary to devise an apparatus so as to easily determine the efficiency of a lamp. It would not do to wait until complaints arose, otherwise the most economic point would be past.

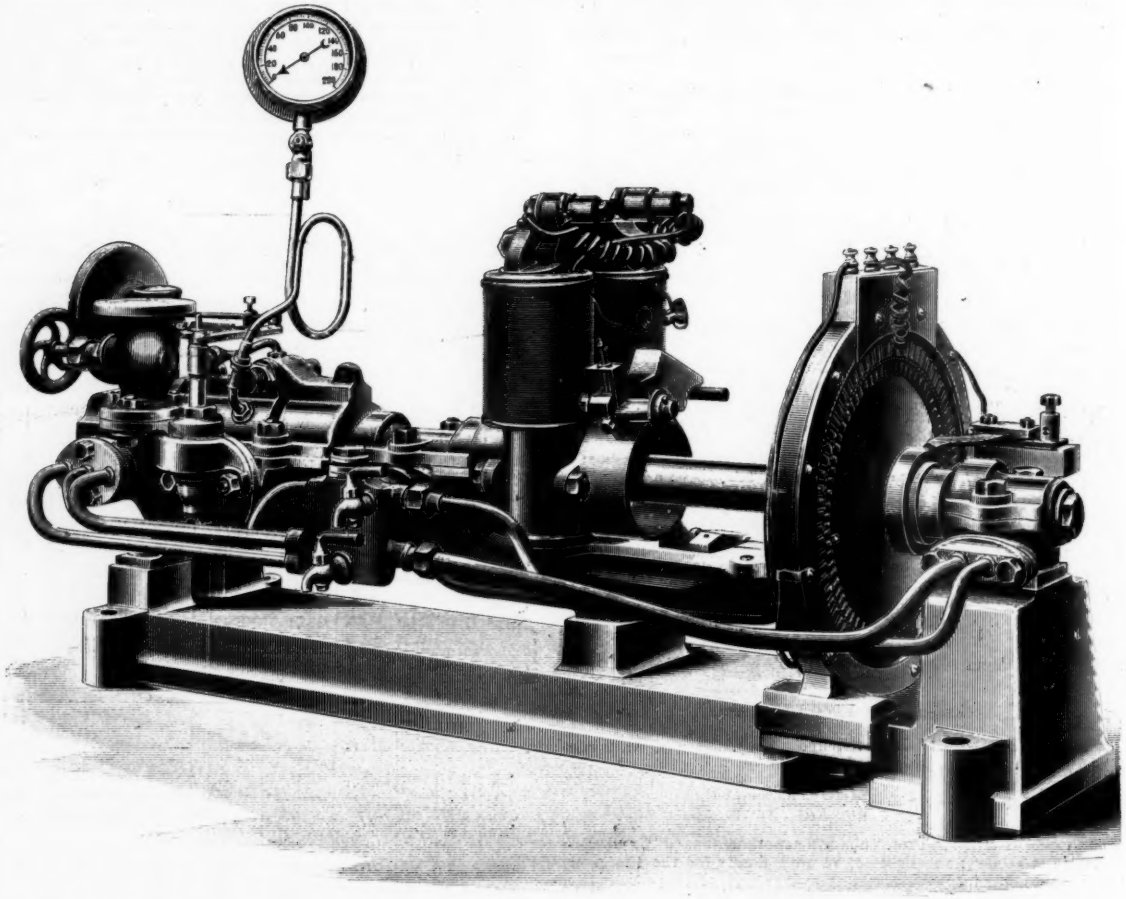
Mr. T. Wolcott drew attention to Mr. Howell's paper, which was read in 1888, and which left out of consideration the depreciation that occurs during the life of a lamp, and yet practically the same conclusion was arrived at—the desirability of running lamps more brightly than is customary. In a nutshell, the lesson that all the prophets discoursing on this subject of "maximum economy" are unanimous in teaching, is, that in the majority of cases the cost of current is a far more important item than that of lamps; it is, therefore, politic to study economy in the former commodity rather than in the latter. A few months' hence lamps will be sold in this country at a shilling each or less, and there is reason to believe that there will be a considerable spurt in the use of electric lighting. We have no wish to check this anticipated increase in popularity, but, to tell the truth, electric lighting will not be much cheaper unless the charge for electric units is correspondingly reduced.

The chairman humorously wound up the discussion by saying that he thought the idea of cutting short the life of a lamp was capable of much wider application than the paper suggested. For example, to human beings who have outlived their usefulness, and whose lives are devoted to rendering those of other people miserable. His early years had been embittered by an elderly male relative, and he thought that had he then had Mr. Hering's suggestions he might have stopped the waste of energy necessary to keep him going and considered it his duty to smash him.

PROFESSOR EWING'S EXPERIMENTAL DYNAMO.

The small steam turbine combined with two dynamos on one shaft, which is illustrated below, has been presented by Messrs. C. A. Parsons and Company, of Newcastle-on-Tyne, to the Engineering Laboratory of Cambridge. Its chief point of interest lies in the fact that one of the dynamos, designed by Professor Ewing, has a periodicity of 14,000 complete cycles per second, at 12,000 revolutions per minute. The steam turbine, which is of an older type than the large one illustrated by us lately, and very familiar in connection with ship lighting, has a normal speed of 12,000 revolutions, and is coupled, as usual, directly to the dynamo shaft.

There are two distinct dynamos shown in the illustration, one being of the usual two-poled type, with a continuous current armature for an output of 15 ampères at 100 volts, at the speed named above. This armature may at will be converted into an alternator by slipping two contact rings on to the commutator, each ring being connected to diametrically opposite segments of the commutator and insulated from the others. The magnets in this case are separately excited, and an output of 20 ampères at 40 volts, with a periodicity of 200 cycles per second, is obtained.



Professor Ewing's dynamo is complete in itself, and is bolted on to a prolongation of the bed-plate. The field magnets, which revolve, consist of two mild steel discs laid together, but insulated from each other, thus forming one disc, which is of conical form, thickest near the axis, to give it strength to resist the centrifugal force due to its high speed of rotation. The edge of this disc is sawn into 140 projecting teeth, and the exciting coil consists of an insulated strip of copper wound zigzag around between the teeth, and held in place by a ring of projecting lips formed by turning a low fillet on the side of each disc, just at the circumference. The ends of the exciting coil are connected respectively to the two discs, whilst an exciting current is supplied from an

external source to two brushes rubbing on the discs. The projecting teeth are thus magnetised north and south alternately. The armature is formed of about 60 thin charcoal-iron disc rings, of about 0·01 inch thickness, built up into a cast-iron frame. The rings are bored to 3½ inches larger than the magnet discs, and are sawn radially by 140 cuts ⅜ths inch deep, thus forming 140 poles around which the armature wire is wound.

It will be seen that there are 70 complete cycles of current per revolution; and at 12,000 revolutions per minute this gives 14,000 complete cycles per second. The output is about 5 ampères at 100 volts.

It is, we believe, intended to carry out a series of experiments on the physiological effects of alternating currents of high frequency, as well as other interesting investigations, by means of this arrangement.

FACTS AND FIGURES ON ELECTROLYTIC CHLORINE AND SODA.

BY EMILE ANDREOLI.

(*Continued from page* 488.)

THAT which I find very remarkable, is that of the five experts, Dr. J. Hopkinson has been the only one to speak of the yield of the electrolysis of sodium chloride by the Richardson-Holland process. I regret to say, however, that for the initiated, and still more, for the non-initiated, his calculations seem to be a puzzle, as instead of telling us plainly how much chlorine and soda is produced per ampère hour, or what the efficiency is compared to theoretical yield, he puts before us a lot of figures and compels us, like boys in a school, to make the best we can out of them.

Messrs. Cross and Bevan had told us that the Le Sueur and Greenwood processes give about 80 per cent.; this very likely was too simple, and does not look highly scientific enough. Look how Dr. J. Hopkinson puts it more hieroglyphically: "I calculate from well established electro-chemical data that 500 ampères passing through an electrolytic tank will decompose 363 lbs. of common salt per week of 150 hours. Multiplying this by 13, the number of tanks, we obtain a decomposition of 4,720 lbs. of common salt per week in the apparatus at Snodland. This agrees with what I have been informed has been the practical experience of the apparatus, namely, that from 40 to 45 cwt. of common salt was decomposed per week. This gives a decomposition of just over 2 tons of common salt for each electrical horse-power applied to the tanks per annum, and I would emphatically state that this figure follows both from well known electro-chemical facts, and also from the practical experience at Snodland, and that there cannot be a shadow of doubt that in continuous working for each electrical horse-power applied, two tons, or a little more of common salt would be decomposed per annum, with a potential difference in each vat of 6 volts, and that any reduction in this potential would cause a corresponding reduction of the power required. Two tons of common salt *should* yield 1·07 tons of Na_2O, that is, of anhydrous caustic soda. This, of course, will not be produced in the form of anhydrous caustic soda, but in the form of commercial caustic alkali, containing an ascertainable percentage of caustic soda; and when this percentage is given, the quantity of commercial caustic alkali obtained can be at once calculated. Two tons of common salt *should also* give, in addition, 1·2 tons of chlorine gas, which may be of course combined with lime to form bleaching powder, and the quantity of bleaching powder so produced will of course depend upon the percentage of chlorine absorbed. We have, then, for every electrical horse-power applied per annum, a production of 1·07 tons of Na_2O, and 1·2 tons of chlorine gas."

From the above, I would infer that the yield of chlorine is 1·2 ton of gas and 1·07 of Na_2O; but why does the eminent expert tell twice that it *should* yield instead of it *yields?*

No doubt we must all be extremely grateful for the precious information Dr. J. Hopkinson gives us, that "chlorine gas may be, *of course*, combined with lime, to form bleaching powder, and the quantity of bleaching powder so produced will, *of course*, depend upon the percentage of chlorine absorbed." Still, it would have been desirable to have something more precise about the practical efficiency of the process, and instead of erratic and vague statements and figures, and of such a display of ecstatic admiration about a well-known form of anode, I would have preferred an unequivocal declaration that the proportion of chlorine and of caustic soda is 1 gr., 1·10 gr., or 1·20 gr., whatever it may be per ampère hour = to so much per cent. of the theoretical efficiency. I intend to return to this point of yield, which is most important. I do not criticise, I would not have criticised the Richardson and Holland process, but I cannot let pass without some remarks, some passages of the reports of the experts. The process works at Snodland is an undeniable fact, but we want to know something more on the system itself. Is it a success? A progress? What is the new departure in the electrolytic production at Snodland of soda and chlorine, *i.e.*, in the decomposition, separation, and recovery of the constituent parts of sodium chloride? Or shall we understand and admit that everybody who has at his disposal a steam engine, a dynamo, a few tanks, and half-a-ton of retort carbon will be able to obtain the same results as those obtained at Snodland?

This is, however, a fallacy, and there is in the electrolytic chlorine and soda something else which makes it a commercial and scientific success, and which depends more upon the talent and ingenuity of the electro-chemist, than of the wear and tear of the retort carbon. When experts such as Mr. Walter Tate, F.C.S., analytical and technical chemist of Liverpool, Mr. John Leith, of St. Helen's, the well known alkali maker and chemical engineer, and Mr. W. H. Massey, give their opinion on the Richardson-Holland process, it is but natural that they confine themselves to the business part of the electrolytic manufacture, to the question of £ s. d., and do not indulge in criticisms or discussions of the merits and demerits of the construction and working of the apparatus.

I will, however, take exception to Mr. Massey, and tell him that he must not be so exulting at the price of 1s. 4½d. per anode, and that it would be much preferable to require but 4½ volts for the decomposition of the electrolytes. Anodes costing 5 or even 10s. a piece will never increase as much the price of chlorine and soda as a pressure of 6 volts. If a loaded van is drawn by four horses, it is extravagance and waste of money to employ six horses to do the same work as four.

"In what follows," says Dr. J. Hopkinson, "*I assume* that the potential difference at the terminals of each tank in which the electrolytic process is conducted, is 6 volts, and *there is no doubt that this figure can be materially reduced, and in the same proportion as it is reduced, will the energy required to produce a ton of caustic soda be also reduced.*"

It would be very interesting to know how, or why, there is *no doubt* that this figure of 6 volts will be reduced, and why it has not yet been done.

"There cannot be a shadow of doubt," he adds, "that in continuous working, for each electrical horse-power applied, 2 tons or a little more of common salt would be decomposed per annum, with a potential difference in each vat of 6 volts, and *that any reduction in this potential would cause a corresponding reduction of the power required.*"

Four times in his very short report he speaks of the reduction of this high E.M.F. below 6 volts; but, in the mean time, this high figure of 6 volts is a cause of inferiority, and I admire the indulgence of the scientist who does not criticise the costliness of the process, and finds quite natural an excessive E.M.F. which really almost condemns the system.

The report of Dr. J. Hopkinson is not quite what would be called a favourable report on the Snodland process, since practically it comes to this:—

Retort carbon is a good material to use for decomposing a chloride of sodium solution.

One horse-power per annum costs £8, and should give with 6 volts 1·2 ton of chlorine gas, 1·07 ton of Na_2O.

3,000 E.H.P., when coal can be obtained at 8s. per ton, will cost about £24,000.

Therefore if you or I, or anyone else, decompose salts with 5½ or 5 volts, we shall produce chlorine and soda cheaper than Richardson and Holland; and if we want only 4½ volts, we shall still be more in advance of them.

A report is not necessarily a testimonial, a piece of more or

less elegant prose containing some data amongst complimentary words and calculations, showing a plentiful return of money. For all parties—I mean for the inventors, for their capitalists, for the public, and for the manufacturers—a report on a new process, such as the commercial production of chlorine and soda by electrolysis, ought to answer the different questions of a programme somewhat like the following :—

What is the density of the chloride of sodium solution ?
What are the anodes and cathodes made of ?
What is the current per square foot of anode ?
What is the diaphragm made of ?
What is the resistance opposed by the diaphragm ?
What about its durability ?
Is the diaphragm attacked either by chlorine or caustic soda ?
What are the advantages or disadvantages of the diaphragms ?
What is the counter-electromotive force ?
Is the general arrangement of the electrodes favourable to the production of the maximum yield of chlorine and soda, or are they too far from each other ?
Is the liquid in the positive compartment entirely free from hypochlorite or chlorate ?
If there is any hypochlorite in the positive compartment, what is its percentage ?
Is there any trace of chlorine in the negative compartment, and if so, what is the percentage of chlorine in the caustic soda ?
What is the proportion of caustic soda and of salt in the liquid of the negative compartment, when run off ?
What about the heat developed in the tanks ? Is there any device to prevent it ?
Do the two liquids in the positive and negative departments circulate ?
How is the solution strengthened after it has been electrolised for a little time ?
Is the system of pipes, feeding tanks, &c., simple enough to be considered as cheap and practical on a large commercial scale.
What is the motive-power absorbed by the pumps, &c. ?
What will be the cost of a pound or a kilo of chlorine ?
Ditto, for soda ?
Does the process deserve recommending as being good, commercial, efficient and cheap ? Is there an advantage in adopting it ?
What is the saving realised by the electrolytic process when compared to the chemical methods ?
What becomes of the hydrogen ? is it lost or collected and utilised ?
What is the yield of chlorine and of caustic soda per ampère hour ?
What is the characteristic feature of this process. Is there a novel, original and important point in it ?

I have also something to say on the report of Mr. Edw. Liveing, A.R.S.M., who says :—"The two great difficulties which have been encountered by all who have attacked this subject are, first, the partial mixing and recombination of the chlorine, liberated at the anode, with the soda formed by the sodium liberated at the cathode; the use of porous diaphragms stops this (except to the small extent of diffusion through them), but as they diminish the section of the electrolyte, and therefore increase the resistance, they cause loss of power and commercial efficiency, and when their porosity is so far increased as to remove this defect, percolation through the diaphragm commences where there is a difference of pressure or level in the neighbouring cells. A diaphragm has, further, the objection of the cost of removal and renewal, an expense of greater or less amount, according to its character and construction. This difficulty, the company seem to me, to have practically removed by the use of the non-porous partitions extending slightly below the level of the anodes and the cathodes, but leaving a sufficient section of the electrolyte between their lower edges and the bottom of the tank. The soda formed at the cathode while it mingles with the brine of the cathode cell and that of the space between the cell divisions and the bottom of the tank, has from its higher specific gravity, no mechanical tendency to ascend into the anode cell, and although diffusion doubtless takes place to some extent at the surface of contact of the soda bearing and the non-soda bearing brine, still from Mr. Leith's results it is evident that this does not occur to any serious extent. The use then of the non-porous division arranged as the company have it, so as to give a horizontal plane of contact between the dissimilar liquids, and an absolute impervious division between them at all points where there is liable to be a difference of level or pressure, seems to me to be the main cause of success."

Has it been a happy thought to replace the porous diaphragm by a non-porous partition ? Does the porous partition increase the resistance to such an extent that it is advisable to do without it ? If so, how is it that the only electrolytic process which has an impervious one, requiring 6 volts, is the Richardson-Holland process ?

Is it a fact that a porous partition is such a big item of expenditure that it must be dispensed with for sake of renewal ? It seems to me that $1\frac{1}{2}$ volts when added to the $4\frac{1}{2}$ volts of the other processes, multiplied by the number of horse-power hours, must represent at the end of the year something much more expensive in a paper mill or a large factory than the renewal of many diaphragms.

I fail to see the advantages which an impervious partition may present in an electrolytic tank, even when, as Messrs. Richardson and Holland say, "It does not extend throughout the whole of the solution under treatment, because the separation of the elements is necessary only at the point where the recombination would take place were there no partition."

But assuming that it is profitable to have an impervious diaphragm which does not go quite to the bottom of the tank, what superiority does it confer to the Richardson and Holland process ?

This arrangement of diaphragms is the same which was used in 1885 or 1886 by Serikoff and Smith, who were the first to employ it, and who described it in the following manner :—

"The trough or vessel is divided into two compartments by a *partition or diaphragm of glass or other non-conducting material which does not quite touch the bottom of the vessel, but leaves a small, clear space under it to allow the fluid or solution to circulate between the two compartments.*"

I must, in fairness, state that Serikoff and Smith had not especially in view the production of chlorine and caustic soda, but simply the bleaching by electrolysis.

The long and short of this so much praised process is that the impervious diaphragm of the Snodland tank resembles the one used by Serikoff and Smith; the retort carbon anode used by Richardson-Holland resembles the one used by Le Sueur and Gibson, and finally the electrolytic system of the Electrolytic Caustic Soda and Chlorine Trust, Limited, requires at least 25 per cent. more electrical energy than the other processes.

These facts and figures deserve attention.

(To be continued.)

DYNAMO GRAPHICS.

By ARTHUR H. ALLEN, Pender Gold Medallist.

In calculating the shunt winding of dynamos, whose carcase dimensions are known, the formulæ—

$$*\mathrm{M}\,\mathrm{A} = \frac{\mathrm{E} \times 60 \times 10^8}{\mathrm{N} \times \mathrm{T}},$$

$$\mathrm{A}\,l = \cdot 315 \times \mathrm{M}\,\mathrm{A} \times \frac{l}{\mathrm{S} \cdot \mu},$$

$$\mathrm{A} = \frac{\cdot 7854 \times \cdot 946 \times \mathrm{P} \times \mathrm{A}\,l}{\mathrm{E} \times 10^6},$$

are constantly in use, the second one most of all. Much time

* M A = Total magnetic flux through armature.
E = E.M.F. of armature at no load.
N = Revolutions per minute.
T = Total turns on armature periphery.
A l = Ampère turns required.
l = Length of one component of magnetic circuit in inches.
S = Section of ditto.
μ = Permeability of ditto.
A = Section of shunt wire in square inches.
P = Mean perimeter of shunt winding.

and trouble may be saved by employing diagrams to effect these calculations, on the principle used by Mr. Carl Hering in his wiring-table, and already applied by Mr. A. T. Snell to the first mentioned formula (ELECTRICAL REVIEW, June 3rd, 1892).

The diagrams here shown are on a scale too small for accurate calculations; but when carefully drawn down about four times as large, they may be relied on to give results averaging within 0·2 per cent. of the exact values, a sufficiently good approximation for most purposes.

It will be seen that the air-gap diagram is invariable; that for iron, however, must be drawn to suit the permeability curves of the particular brands of iron in use. In the examples shown, the permeability curves were, for convenience, taken from Munro and Jamieson's Pocket Book.

The shunt-winding formula, due to Mr. Carl Hering, is independent of the length and depth of winding-space; the constant ·946 is correct for 98 per cent. conductivity copper at a final temperature of 100° Fah.

In order to explain the method of using the diagrams, it will be most convenient to fully work out an example, assuming average values and dimensions.

Required, the shunt-winding of a dynamo to the following data:—

160 turns on armature periphery;
105 volts at terminals, at
600 revolutions per minute.
Leakage coefficient, 1·25.
Mean perimeter of shunt winding, 40 inches.

	Armature.	Field.	Air-gap.
Cross-sectional area ...	70	100	240 sq. ins.
Magnetic mean length	15	60	1·25 ins.

$$\text{Then armature flux} = \frac{105 \times 10^8 \times 60}{160 \times 600}$$

$$= \text{about } 6{\cdot}6 \times 10^6 \text{ C.G.S. lines.}$$

$$\text{Field magnet flux} = 6{\cdot}6 \times 10^6 \times 1{\cdot}25$$
$$= 8{\cdot}25 \times 10^6 \text{ C.G.S. lines.}$$

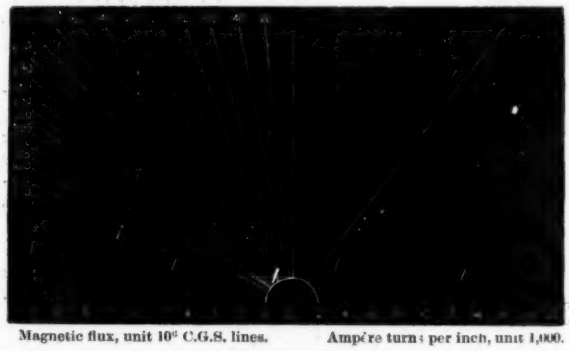


DIAGRAM 1.

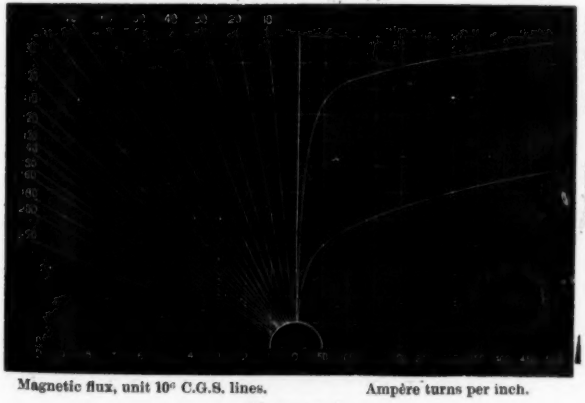


DIAGRAM 2.

On No. 1 diagram, left of base line, find 6·6; follow the ordinate to meet the line marked 240; from the point of intersection pass along the abscissa to cut the slanting line in the right-hand compartment, and thence drop to the base-line, where the value, 8,700 ampère turns per inch, is read off.

Then 8,700 × 1·25 = 10,870 ampère turns for air-gap.

Next, take 6·6 in same place on No. 2 diagram. Proceed vertically to meet the line marked 70, thence horizontally to the permeability curve for wrought iron, and vertically down to the base line at 45 ampère turns per inch.

45 × 15 = 675 ampère turns for armature.

Assuming that the field-magnet iron is of the same quality as that used for the armature, substitute 8·25 for 6·6 in the last case, 100 for 70, and read 23 ampère turns per inch on the base line.

23 × 60 = 1,380 ampère turns for fields.

Total ampère turns = 10,870 + 675 + 1,380 = 12,925.

Turning now to No. 3 diagram, it is evident that

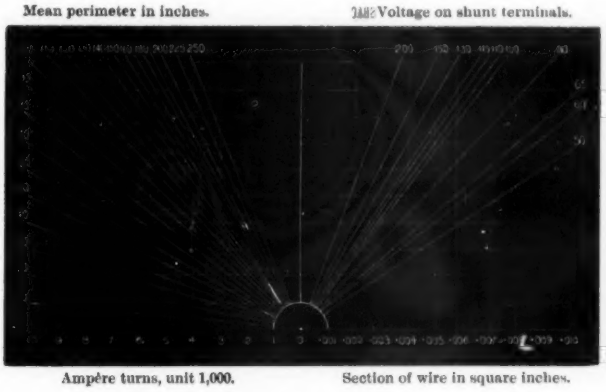


DIAGRAM 3.

13,000 is beyond its scope; but divide by 2 and read 6·45 $\left(= \frac{12{\cdot}9}{2}\right)$ on left base line, follow up to meet the 40 inch line, across to 105 volt line, and down to base line. The reading is ·00185 square inch; this must be doubled for 12,900, and becomes ·0037 square inch. The wire corresponding to this is ·0686 inch in diameter, or ·0608 inch square. This wire will be found to give very nearly 12,900 ampère turns, whatever the length and depth of winding space, provided that the voltage and mean perimeter are correct as above, and that the working temperature is about 100° Fah.

It is easy to add another quadrant to Nos. 1 and 2, to perform the operation of multiplying the ampère turns per inch by the length of the magnetic circuit, but this doubles the size of the diagrams and renders them unhandy, without being of much advantage.

These diagrams were devised in September, 1892, for Messrs. J. H. Holmes and Company, to whom the writer is indebted for permission to publish them.

PRINCIPLES OF PRIMARY BATTERIES.*

BY E. F. NORTHRUP.

The Positive Electrode.—Potassium, sodium, and magnesium, together with their zinc alloys, cannot be used in electrolytes which contain any water, as they almost universally do, because their affinity for oxygen is stronger than that of hydrogen, and consequently the water is decomposed with a consumption of the electrode and with evolution of hydrogen gas. Cadmium, and the metals which follow it, give a lower electromotive force than zinc, and are not cheap enough as yet to make them more economical than zinc. Iron has been used, but it has disadvantages besides its low electromotive force, such as the formation upon its surface of

* Abstract of paper on "Some Principles that must be Observed in order to make a Good Closed Circuit Battery, and a New Portable Dry Cell Described in which these Principles are Applied," read before the Electrical Section of the Franklin Institute, December 28th, 1892; January 24th, 1893.

an insoluble and non-conducting film which runs up the resistance of the cell. Thus zinc, considering its cleanliness, cheapness, and high potential, appears to be the best metal to employ for the positive electrode. Amalgamating it diminishes local action and slightly raises its electromotive force. It may be alloyed with advantage only where fine adjustments of electromotive force are sought, as might be the case in cells designed for standards of electromotive force.

The Negative Electrode.—Much greater opportunity is offered for improvements in the negative electrode, both in respect to material and form. Negative electrodes may be divided into (1) those which are depolarised by an element not chemically united with the electrode; (2) those in which the depolarising element is chemically united with the electrode, and (3) those which depolarise themselves chemically, as in the single case of arsenic, or mechanically, as by the exposure of a large extent of surface.

If the first class is used, then the following considerations must determine its material; the lower its potential the better. But if the depolariser that is used is reduced by the action of the current to a metal which is deposited upon the electrode, then the electrode must have exactly the same potential as the reduced metal. Otherwise wasteful local action may take place, for a couple will be formed between the reduced metal, which is at one potential, and the electrode, which is at another. For example, with copper oxide for a depolariser, copper and not carbon should be used for the negative electrode.*

When, on the other hand, the depolariser is an element, or a compound which is reduced to an inert material, such as PbO_2 reduced to PbO or Pb_2O_3, carbon makes by far the best electrode. It is cheap, nearly as negative as platinum, and can be made to serve the purpose of a porous cup as well as electrode.

The form given to the electrode is often quite as important as its material, especially when carbon is used. Most of the solid compounds employed as depolarisers have a high resistance, and all the elements which will serve the purpose are by themselves non-conductors (arsenic excepted), hence, if the carbon electrode is embedded in such a depolariser and exposes but a small surface, the cell will have a high internal resistance and much of the electrical energy will be unavailable, as it will spend itself in heat within the cell. This is the way cells are often constructed, viz.: with an electrode surrounded with a depolariser of low conductivity. Liquid depolarisers, excluding the liquid element bromine, are not open to this objection, and hence the high efficiency of the Bunsen element, the gravity cell and others of that class.

The Electrolyte.—All electrolytes decrease in resistance with increase in temperature, and this makes one of the tests of the class in which to place a substance. Generally speaking, a dilute solution has a lower resistance than a concentrated one. Acid and alkali electrolytes give, as a rule, higher electromotive forces than salts, but they are open to the objection of being liable to consume the positive electrode, which means that some of the energy stored up in the cell is given out in local heat instead of electricity. As a rule, salts are better adapted to hermetically sealed cells, and acids or alkalies to open cells. If a salt is used, it should usually be a salt of the metal employed for the positive electrode with an acid radical the same as the active depolarising element, for after the cell has been in action such a salt is always formed, and if other salts are present there is a liability that double salts may be produced, which will increase the resistance of the cell, or at least make complicated what might otherwise be simple. Thus in a zinc carbon couple, with bromine for a depolariser, zinc bromide would be better to use than magnesium chloride. This is not, however, an inflexible rule to follow, for special cases may require special salts.

The chief thing that has to be taken note of is that the excitant is not of a kind or concentration to dissolve any part of the cell and produce local action. This is the reason that K O H cannot be used with advantage in a silver chloride cell, though the electromotive force is much greater than with $N H_4 Cl$, which is usually employed.

The Depolariser for the Negative Electrode.—As the negative electrode is polarised by the formation upon it of hydrogen, it can only be chemically depolarised by such substances as will unite with nascent hydrogen. Now, whatever compound is used, the depolarising is actually done by one of these seven elements, As, S, O, Fl, Cl, Br or I, or one or more of these in combination. Theoretically, some other elements belonging to the group of non or semi-metals will unite with nascent H, but their affinities for H are weak and practically could never with advantage be used. Arsenic and sulphur also have weak affinities, giving under the most advantageous circumstances less than a volt, and generally less than half a volt. Fluorine is far too powerful to be used, either free or in combination. So, practically, a battery always makes use of O, Cl, Br or I for its negative depolariser, though these may often act in a combined state as in the case of the acid radical SO_4. As the depolarising is actually done by one of these four elements or two of them in union, it is obvious that the other element or elements with which they may be combined are so much inert material which play no part in the production of the current, and usually only act to clog up the cell, increase its internal resistance, and add to the total bulk occupied by the materials. Hence, the theoretically perfect cell would employ electrodes at opposite ends of the potential scale, and have the negative electrode depolarised with the most negative free element.

There are certain difficulties connected with the use of free elements as depolarisers, which have led to the adoption of their compounds instead. In the first place, any element or compound which will give up an element capable of uniting actively with hydrogen, and hence serve the purpose of a depolariser, will also attack the positive electrode of the cell. Therefore, the depolariser must be kept separated from the positive metal.

In respect to efficiency, a liquid depolariser is much better than a solid depolariser, and a gas best of all, for with solid substances the exhausted particles cannot be replaced as in the case of liquids and gases. For this reason the compounds, $Pb O_2$, $Mn O_2$, and others of similar qualities do not depolarise effectively, or, if they do, at least cause a high resistance in the cell. There is an exception to this rule in the case of cells made on the principle of the silver chloride and copper oxide cells, in which the reduced metal is left in a spongy state, which permits the hydrogen to be absorbed into its mass until it comes in contact with the still unreduced oxide or chloride.

Of the free elements, bromine, while being one of the cheapest, is a very powerful depolariser, giving with the combination $Zn / Mg Cl_2 / Br / C$, 1·9 volts. It is comparatively easy to handle, and when dissolved in $C S_2$ loses largely its fuming nature, and if properly used does not lose its depolarising properties. Some experiments made with this element showed that the carbon electrode could be made to serve the double purpose of electrode and porous cup. This was accomplished by taking a piece of an ordinary electric light carbon and boring a $\frac{3}{16}$ths inch hole down the centre for a distance of 2 inches. This hole was filled with grains of carbon, and free bromine was then poured into the hole. The hole was stopped with a carbon plug and connection made with a platinum wire. Such an electrode, $\frac{1}{2}$ inch in diameter and 2 inches long, was placed in the centre of a five-ounce beaker containing a sheet of zinc for the positive electrode and with an excitant of K O H. This arrangement gave over 2 volts and $3\frac{1}{2}$ ampères as read upon a low resistance ampèremeter. Such a high efficiency was of short duration, as the bromine soon became exhausted, but the experiment goes to show that use may be made of non-conducting liquids for depolarisers when applied in this way. If porous cups could be dispensed with and the free elements O, Cl, Br or I in solution used in some such manner as the above, a very high efficiency might be attained.

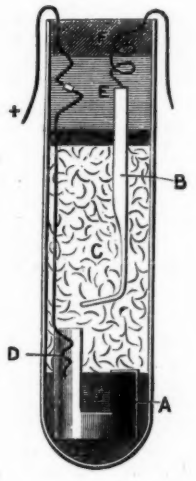
In all so-called dry cells the electrolyte is used in the form of a semi-liquid paste. As this paste is usually employed, it merely serves the purpose of holding the contents of the cell in a more or less rigid condition, by which means the battery is made more readily transportable than it would be if it contained a liquid free to move about. But the paste in a hermetically sealed cell can be made to serve a much more important function. Where the product of the union of the hydrogen with the depolarising element is an acid, this acid must be neutralised, in order to prevent its action upon the zinc, and the consequent formation of a gas. This is best

* Since the above was written I have made experiments which show that salts of mercury and carbon can be used together without any appreciable local action taking place.—E. F. N.

accomplished by the use of a paste which consists of some basic material. All organic substances, like starch or the hydrate of silica, which are often used as pastes, are non-basic, and will not serve the purpose of neutralising an acid, and in a small cell are of little value. Any cell which uses as its depolariser a salt with a haloid acid radical, should therefore make use of some such product as Mg O, or Zn O, if gasing is to be prevented.

The Seal.—The seal for a small dry cell is one of its most important parts, and one not so very easy to construct well. It is astonishing what deterioration and changes time will work upon a battery. In fact, the time test for a battery, as for most things, is an extremely important one. "Will it last?" is the pertinent question, and the way this must be answered depends not a little upon the security of the seal. A warning, however, is easier to give than a remedy, as the many patents taken out for seals alone will go to prove. The expansions and contractions that take place with changes of temperature are almost certain, sooner or later, to produce an opening through which the contents of the cell will creep and cause its final destruction, unless the seal be well constructed. The neophyte inventor cannot give too much attention to this apparently insignificant feature of a closed battery.

A new "Test" Cell.—As portability is a great desideratum with test cells, and as only a very small current is taken from them, the cell designed for this purpose was reduced



A = carbon electrode.
B = zinc electrode.
C = paste made of $Al Cl_3$ + Zn O + $Mn O_2$ + $H_2 O$.
D = fine platinum wire moulded into carbon electrode.
E = viscous seal.
F = plaster Paris seal.
G = depolariser, which may be $I_2 S_2$ giving 1·35 volts, or Hg O + I giving 1·65 volts initially with an average of 1·4 volts.

SMALL IODINE TEST CELL, 2 inches long by ½ inch in diameter.

in size very much from those usually used. They are made in what are called round bottom specimen tubes. The smallest size constructed have a length of 2 inches with an outside diameter of only half an inch (see fig.). In spite of this small size the average resistance of these cells when first made up is not greater than 25 or 30 ohms, and after the cell has been put in use the resistance gradually falls a few ohms. The electromotive force of this cell when the depolariser is sulphur iodide ($I_2 S_2$) is 1·45 volts. They will thus average 1·4 volts. The silver chloride cell with a case of paper and paraffin upon it, which is required to keep the glass from flying when they explode, measures 2¾ inches in length by ⅛ths of an inch in diameter; being round they thus have a total volume of 1·62 cubic inches. One of the cells here described, which I may call the iodine cell, iodine being the active depolariser, has but 4 cubic inches, or less than one-fourth the volume of the silver chloride cell; or 100 silver chloride cells would require 76 square inches of space against 25 required by an iodine cell. Further, as the electromotive force of an iodine cell is about 1·4 as against ·9 of a volt for a silver chloride, we have

$$\frac{1}{3} \times \frac{\cdot 9}{1\cdot 4} = \frac{3}{14}$$

or practically one-fifth the space is required to obtain a given electromotive force as is needed if silver chloride cells are used.

The seal in these cells is made as follows (see fig.): The zinc electrode is held in place by a cork, over this is poured a hot mixture of gutta-percha, pitch, and resin oil. This viscous material is then made secure by having poured over it a layer of the same mixture with an equal part of plaster Paris mixed through it. The terminals are both brought out of the top of the cell (see fig.), one being of platinoid and the other of copper wire, so that the poles may be distinguished from each other.

The battery problem is not an electrical one merely. It is chiefly a chemical and mechanical question, and one which a person with only an electrical knowlege can scarcely hope to undertake with success. There are many improvements yet to be made in primary cells, and those who take the work up should bear in mind that a good battery, like anything that is at all complicated, cannot be stumbled upon, but must be laboriously and logically studied out, and then proved by careful experimenting to be of sterling value.

The author has continued experimenting upon different forms of dry cells, and has learned that, on the whole, Hg O 1 pt. plus I 4 pts. ground together, a little alcohol being added, makes the most efficient and durable depolariser he has yet tried.

FAULT FINDING IN CONDUCTORS.*

[EXTRACT.]

THE great extension which the distribution of electric light from large central stations has acquired, and at the same time the enormous growth of nets for conducting high-tension currents, have brought to the front the problems of the security of central stations. An especial and justifiable attention is being drawn to the control and maintenance of the cable nets—that costly portion of the installations. It is undeniable that the task of detecting faulty places in conductive nets during work must be pronounced a "burning question," in the strictest sense of the word, and that the arrangements for its control and safety are a necessity which cannot be ignored.

The present methods of measurement, even the most difficult, have proved themselves insufficient for practice on the large scale, not alone on account of the expenditure of time and materials, but because the total value of the insulation for a large region to be lighted must be very low. In Berlin, *e.g.*, where at present about 160,000 normal lamps are fed by the cable net of the Berlin-Electric Works, a higher insulation than 14 ohms cannot be demanded at the tension of 110 volts.

For block-centrals and for smaller installations the conditions are decidedly more favourable, inasmuch as in such cases voltmeters, or, if possible, signal voltmeters may be used to advantage for the permanent control of the state of insulation. Indeed, hitherto, too little value has been laid on the use of these simple instruments, which have for some years been successfully introduced for these purposes by the General Electric Company. But, in installations of such dimensions as that of the Berlin Electric Works, whose sphere of action embraces a surface of nearly seven square kilometres with the total length of 700 kilometres for all the underground street cables there occur far greater difficulties. The frequent external damages to the cables occasioned by operations in the paving, carried out by strangers, show the necessity for a trustworthy and self-acting system of indicators. For this purpose, in the beginning of 1892, several systems of automatic fault-detectors were elaborated by the company and introduced at the Berlin works.

These patent systems effect their purpose of at once indicating any damage to the cable by an alarm signal, and also show the district in which the injury has taken place. For this purpose, test wires are used, which are twisted up with all the cables connecting streets and houses, which also allow

* Discourse delivered by Dr. M. Kallmann, at the meeting of the Electro-technical Association, on February 28th, 1893, and published in the *Elektrotechn. Zeitschift*, 1893, No. 11.

of a measurement of the tension at various points of the net, especially at the ends of the feeding leads. These test wires are inserted in such a manner that there is always a known difference of tension produced between the copper core of the wire and the adjacent test wire. On the occurrence of an injury to the cable, this difference is essentially modified in consequence of the short-circuit produced between the test wire and the core of the cable. By this a relay inserted in each test wire circuit is actuated, and an alarm signal is set in action. In this manner the occurrence of a defect in the insulation in the cable net is at once announced at the central station without any disturbance in the measurement effected by means of the test wire. The district where the fault lies is indicated by the number of the relay shutter which has fallen, and thus the defective cable is easily found and the defect remedied.

Besides this apparatus for indicating an injury, the same company has arranged a system of a self-acting indication of an earth connection, available under all conditions. By its means a permanent easy control of the state of insulation is effected in any net of whatever extent, whether aerial or underground, whether cables or naked leads laid in channels. This applies not alone to the entire net, but to every small district and under the most different conditions of work, and there is given at once an alarm and an indication of the faulty place.

Setting out with the experimental fact that in earth connections the main part of the electric energy is annulled in the shape of thermic effects at the place of the earth connection, and that only a small part is consumed as a fall of tension, the latter invention consists in determining the amount of the potentials prevailing at different points of the earth. The place of the defect is then at once automatically indicated at the Central by signal relays, or by a simple galvanometric indication (voltmeter showing up to 10 volts).

We are thus perfectly enabled to fix at will the sensitiveness of the control arrangement, *i.e.*, we may apply relays of such a degree of sensitiveness that they are actuated at a tension of $\frac{1}{4}$ volt, or at $\frac{1}{2}$, 1, or several volts, according as it is desired to have an indication of slight, or only of considerable earth connections. When the region of the fault has been indicated, we separate in the ramification box the control wires which branch out from thence. From the reduced tension of the various earth potentials of the district we find the direction, *e.g.*, the front of a block of houses in which the fault lies. By procuring as many and as good earth leads as possible of each control wire in each district we obtain more definite indications as to the faulty place. The more numerous and smaller are the several districts, the more accurate is the localisation of the fault.

The theory of this system depends on the theory of the distribution of current in the earth, and from its laws follow the principles of the influence of high tension leads upon feeble currents, *e.g.*, telephone nets. The means for the diminution of these effects, such as the use of bright (naked?) leads as intermediate conductors in a multiple lead system may be inferred from this theory.

By these different systems of alarms which complement each other, we may obtain a complete guarantee for the supervision of even the most extensive net.

PRIME MOVERS FOR SMALL POWER GENERATING PLANTS.

The progress of the electrical industry has been largely dependent upon the facilities obtainable for driving purposes. The dynamo being essentially a machine or appliance for conversion of power from one state into another, is of service only when supplied with energy from some source, which usually takes the shape of a steam, water, or gas engine. For private house lighting on anything but an extensive scale the steam engine is regarded with disfavour, and naturally so. The noise, dirt, smoke and attendance required, to say nothing of the expense, are considerations sufficiently powerful to detract from the usefulness of this type of engine, provided a reliable and efficient substitute is obtainable. Certainly the steam engine, by a return in some of its details to the first arrangements adopted by the Cornish pioneers, has been rendered of use where small powers only are demanded, and in situations in which the available attendance is necessarily limited, and of an unskilled kind. In this direction the Davey and Friedrich motors, each in the hands of a well-known and reputable firm, have attained some degree of eminence, and, although not obtaining that universal demand anticipated for them, have done good work in the cases where they have been laid down. Of recent years, and especially since the expiration of the Otto patents, gas engines have been forthcoming in numbers wonderful, in promises abundant, and, in many particulars as to structure and arrangement, ofttimes amazing to the engineer. Fierce competition has to some extent, at least, lopped off the excrescences, and of those on the market to-day it may fairly be said that they are all reliable, and with but little beyond personal fancy to choose between them. Records of tests have been forthcoming from time to time, and accurate data have been furnished by those responsible for the experiments, so that trustworthy deductions can to-day be drawn as to consumption and the other functional particulars of any well-known type of engine, or generally when comparing gas power with steam power or alternative prime movers. Probably the engine which has been most generally used is the Otto, on account of the favourable position in which its makers were, holding as they did what may be considered to be master patents for what was at the time the recognised leading system of cyclical operations. When it, as a new machine, was put on the market, the greatest pains were taken in the design to secure the maximum possible effect in the simplest and most economical manner. The result was that on the expiration of the patent the firms who entered upon gas engine manufacture in competition with the existing makers very generally copied fairly closely the fundamental design, making additions to or modifying as they felt inclined, but only slightly altering the appearance here and there. It must be admitted that in the Otto engine we have excellent models, and since the expiration of the patents for this pattern of engine, the tendency for leading makers to adopt the Otto cycle has become general. In many cases it is not admitted that they regard the Otto cycle as being the best arrangement to adopt with a view to increasing efficiency to the highest percentage, or of ensuring the steadiest possible running; but they say that while the Crossley patents held they could not help themselves, and were compelled to utilise other cyclical features. On the term of the Otto patents having reached its close, they found that although they believed in many cases that the cycle in use was superior to that which was now at their disposal, if they cared to make use of it, the market prices compelled them to build engines *à la* Otto, on account of the lower cost of manufacturing such patterns, the type recommended by themselves being so expensive to turn out, that despite their advantages in other ways, they could not hold their own in open competition, and the change was forced upon the firms who desired to continue manufacturing upon a large scale. We have heard this statement more than once, and it has appeared in print in the columns of one of the leading engineering papers; but it cannot be said to cover the ground so fully to-day as it did a few months after the Otto cycle was thrown open to the public. We have lately seen a new engine, probably the latest arrival, and for small powers for electric lighting purposes it seems to be extremely well fitted, owing to this end having been kept in view in preparing the design. The engine is built upon the patents of Messrs. Robinson, of Manchester, by Messrs. Norris and Henty, Limited, of Upper Thames Street, and in its construction there are one or two points of engineering interest. At first sight the most noticeable peculiarity is that the diagonal plan is adopted for the building up of the principal parts. Space is thus saved to some extent, and the deep bed is used as a cooling tank, although this feature seems to be open to well merited criticism, if not even strong objection. It would be all very well to dispense with the cumbersome and unsightly water tank generally supplied with gas engines of any size, were an efficient and satisfactory substitute forthcoming; but if nothing better can be proposed than to utilise a hollow cast-iron bedplate for this purpose, then by all means let us retain the circular tanks which have done such good service in the past. The circulation must be interfered with in an irregular tank, and

the radiating surface—an all important matter—can only be a fraction of what would be available with the old system, to say nothing of the thermic resistance of the thickness of cast-iron, through which the heat must pass. For an engine of any size which requires a water jacket, let the circulation be unimpeded, and a suitable tank be provided; while for sizes so small that a separate cooling chamber is considered unnecessary, let them make use of radiating plates on cylinder, which, if not very sightly, are at least of use, although not so efficient in their action as to render them applicable to cases where the amount of heat to be dealt with is considerable. The Robinson-Henty engine works on the Otto cycle, with the usual tube ignition, but the valve gear is novel. There is only one mechanically actuated valve, and it is in the method of controlling this valve that an ingenious departure has been made. The common method of giving motion to the valve gear has been by a cam shaft, parallel to the centre line of the engine, and driven by bevel or spur gearing from the crank shaft, so as to make one revolution for every two piston strokes. On this engine an ordinary eccentric and eccentric rod or spindle is used, this rod lying at its lower or loose end upon a small ratchet wheel, and one opening of the valve is obtained for every two revolutions of the crank shaft, as follows. The eccentric rod moves the ratchet wheel round the distance of one tooth at each revolution of the crank shaft. The teeth of the ratchet wheel are alternately shallow and deep, and therefore the position of the eccentric rod will be higher or lower as the tooth upon which it rests is shallow or deep. Each alternate stroke corresponds with the tooth in which the rod lies. This difference in height is sufficient to cause it to hit or miss the valve spindle. This gear does away with the complicated and costly cams, springs and tappet valves, so long associated with gas engines, and brings the valve and its gear to a simplicity on a par with that of the steam engine, although the object to be aimed at is attained, and in a more sightly way, which is a point of some weight with the general public. The general design of the engine should render it very readily adapted to dynamos driven by jockeyed belts or friction gearing, and using the engine bedplate or pedestal as a foundation. With the attempts made a few years ago to perch a dynamo upon the rounded back of a cylinder, and call the abortion a combination set, we had little sympathy, for neither as a mechanical job nor as a seemly whole did the result warrant trial. Where, however, as in this case, the cylinder is out of the way, and a really sound construction can be got out, there is greater hope of success in what may be reasonably regarded as a gas-electricity conversion machine.

For situations where oil or gas is not readily available, and steam engines are too expensive to render their power feasible, hot-air engines have for some time been making steady progress, although so far electric contractors look after the plums, and have had no time to gather the currants and raisins of lighting work. It would, however, be worth the while of some of the smaller of our numerous wiring firms not to forget that medical men and others are only waiting to be taught what help lies in electricity to aid them in their necessary and important operations, and a new era would dawn for medical electricity. At present few practitioners regard electricity except as a something of a nature entirely unsuited to help the healing art, and as a medium for imposture in most cases where its name is associated with curative virtues. Now the great deterrent to the majority of professional men in making use of electricity is that the only general available source is a primary battery, and one can well understand the collapse of courses of treatment which rely for their *vis vivendi* upon such fitful things as the batteries of surgical instrument makers. In this and many other cases a small dynamo would replace the battery, and bring success where failure resulted before, but the motive power is a consideration oft without an acceptable solution. In electroplating, and some others of the few remaining occupations of the nature of cottage industries, and which, like the cobbler, still hold their own against the rings and corners, the factories, and other creations of this *fin de siécle* age, the use of electricity in small quantities is a desideratum, and in these cases the Grove or Bunsen battery has had a long and untroubled reign, though likely now to be supplanted by small power motors, and a dynamo constructed with a view to the most efficient supply for the process in connection with which it is used. Hot air engines have not received the attention up to the present which, from the perfectness of the medium employed in the transference and utilisation of heat, they would seem to deserve. Probably this is due to some extent to their having been handled by firms whose reputations have not sufficed to do for them what greater fame has done for other classes of engines. The engine having the most practical record in this country is that made under the Robinson patent in the hands of Norris and Henty, Limited, and motors of this type have already been set to drive small dynamos with encouraging results. That there are greatly increasing needs for engines of low power is indisputable, and the air engine should, from its fundamental principles, find a field in which the small attention required, the economy in fuel, and the possibility of using coke and slack in slow combustion furnaces as heating agent, would enable power to be applied in cases where any other method of driving would be held to be out of the question. In the case of the Robinson engine, the demand for motors by electrical contracting firms has been the means of increasing the size up to 1 H.P., and a coupled plant of double this power, with special dynamo arranged to suit the build of the engine, is under consideration. Of other types, that of Hargreaves has received most notice, and the model thermic filter with which the maker's name is associated, caused the engine to make its appearance before most of the provincial engineering societies, but latterly less has been heard of it, and it is difficult to mention an instance in which it has been applied to electric machinery. Taking things all round, we should do well not to despise the days of small things, and to remember that it is not the lot of everyone who desires to make use of electricity as a domestic help to be situated within reach of an electric power company's mains from which to obtain a supply.

THE LAMP SITUATION IN AMERICA.

THE *Electrical World* is indefatigable in its efforts to gather enlightened views on the situation from every interested quarter. The issue for April 1st contains a further collection of communications on the subject, together with the account of an interview with Mr. Fish, general counsel to the General Electric Company. This gentleman summarily disposed of Mr. Terry's questions, stating that he did not think it was possible for the General Company to obtain control of the lighting industry, and that there was therefore no necessity to discuss whether such control would be advantageous. As regards the company's policy, nothing could be formulated until litigation was ended. He was fully aware of the gravity of the situation, seeing the multitudinous and opposing rights of licensees, supply dealers, contractors, &c., &c., and none deplored it more than his company did. When litigation was over it hoped to arrange matters in an equitable and satisfactory manner all round. This desirable condition of things had been expected to come about at the conclusion of the Sawyer-Man case, but outside manufacturers had taken no notice of that decision, and it had been necessary to deal with each individually, one after another. This had been done, and is being done as expeditiously as possible. The next case was against the Columbia Lamp Company, and it was to come up at St. Louis on April 11th. As regards the sale of lamps, the company was clearly bound to its licensees, and *cannot* sell lamps indiscriminately. It does, however, sell to other consumers, but requires to be informed where the lamps are to be used, and it takes care that they shall not be used in competition with the legal licensees. The supply dealer is indignant at this demand, and looks upon it as an unwarrantable interference with his business; but the company can follow no other course. Up to the present, Mr. Fish was glad to say, the Edison and Thomson-Houston licensees had, as a rule, looked at the question very reasonably, and almost all the trouble had arisen at the instance of uncompromising infringers who had no legal rights in the matter whatever.

A lengthy communication was received by the *Electrical World* from a large consumer of lamps, who owns an isolated plant, and it may perhaps be taken as representative of that class of customer. This gentleman seems to view the situation

with very grave fears indeed. He referred to a letter he had received from the Edison Illuminating Company, of New York, courteously requesting him to apply to that company in the future for supplies of lamps, and further intimating "that *all users* of infringing lamps would be held responsible, in spite of assurances of indemnity which might have been given by manufacturers. The company, however, had no wish to inconvenience consumers or concerns supplying such lamps, and hoped to come to a general settlement with them; but pending such settlement, it was willing to be lenient with all lamp consumers who reported the present number of non-Edison lamps installed, and who agreed in future to purchase Edison lamps only. Finally, the company hoped to make the use of electric lighting very popular, and thus be able to materially reduce the charge for current; and, if Mr. —— wished, a representative would call on him with a view to supplying him with current direct from the central station. The owner of the isolated plant fears that this communication may be "the beginning of what may be a gigantic plan of the Edison Illuminating Company to control the entire electric lighting and power interests of New York City." He proceeds to argue in very characteristic American phraseology that what the Illuminating Company would naturally most desire would be to obtain the whole lighting in its own hands, and he was candid enough to admit that if he was "in its position to-day he should force the matter as far as possible to the end which he had stated."

Mr. Ward Leonard, electrical engineer and contractor, and formerly of the Edison Company, expresses his opinion to the effect that, whilst it may be possible to control industries such as telegraphy, oil, metals, coal, &c., no such control is possible with the lighting industry, owing to the circumstance that in its present condition, methods and practices are ever changing and modifying. Electric transmission of force has, as yet, barely commenced, compared with what it is likely to develop into in the future, whilst radically new systems of electric lighting, such as Tesla has been working on, may any day become capable of practicable application. He was clearly of opinion that control of the industry would be most undesirable. Another gentleman expressed opinions to the same effect, and further prophesied the collapse of the telephone monopoly in spite of its immense power. Mr. C. H. Wilmarding, of the Chicago Arc and Power Company, also concurs in the impossibility of the General Company to obtain control of the industry, but he is singular in his belief that such combination would be generally beneficial. The popular idea of such combinations was erroneous. Better goods at minimum cost was the result. (Correct enough, doubtless, provided the industry has reached a point of maximum perfection, think we.) Another deeply interested authority expressed his views with regard to the pending litigation at St. Louis, and stated that "he believed that testimony was already to hand to establish, beyond doubt, that Goebel invented the incandescent lamp before Edison had anything to do with it." A very strong case was to be presented, and "the lamps which Judge Colt thought were inoperative would be proved to be in every way practical."

PROCEEDINGS OF SOCIETIES.

Some Applications of Electricity to Chemistry.* By James Swinburne.

III.

The next division of my subject is the electrolysis of gas. The study is new, and even the expression "electrolysis of gas" is unfamiliar; nevertheless, according to the most recent researches, gases are, to all intents and purposes, electrolysed by the electric discharge. It has been known for a long time, however, that oxygen can be converted into a peculiar modification, namely, ozone, by the electric discharge. This substance is of great value as an oxidising agent for use in bleaching and disinfecting. Ozone is now made industrially. An alternating current dynamo is employed, and the pressure is raised from 10,000 to 30,000 volts, this pressure being applied in an ozoniser. The various ozonisers in use are much the same in principle. If two electrodes were placed close together in, say, oxygen or air, there would be no electrical discharge to speak of until they were brought so close that a disruptive discharge took place. An arc would then be formed, and this is not what is wanted. What is required is some arrangement by which the air can be broken down. If a piece of glass is placed between the electrodes, air may be broken down, and the glass will support the dielectric stress itself so that there is no arc. As the pressure rises from zero the electric displacement in the air and glass increases until stress in the air causes that part of the circuit to break down. The glass then for the moment bears nearly the whole pressure. As glass has a very high specific inductive capacity, it allows a very large electrical displacement in proportion to its thickness and to the pressure applied; it therefore allows a considerable discharge through the air. Immediately the discharge has taken place the air recovers itself, so that there is little or no stress on the air, nearly the whole being on the glass. As the pressure rises more stress is put on the air and on the glass, and the air breaks down again, and so on, until the top of the alternating wave of pressure is reached. As the pressure falls, the glass, being under stress, communicates its stress to the air again and breaks it down in the reverse direction, and so on until the zero of the electric pressure is reached. The alternating pressure thus produces a series of electric discharges, which have here been explained according to the more recent methods of regarding the action of electric stress on dielectrics. In older language it would have been said that the electricity was charged on to the surface of the glass. So far we have spoken of a series of disruptive currents across the air space. Much of this is really oscillatory, so that in the ozoniser there is really an irregular alternating current of very high frequency. In fact, most of the well-known frequency experiments can be shown by means of a glass plate and a high-pressure transformer.

Practically, the ozoniser has two plates of glass, the disruptive discharge taking place between them, the electrodes being on the outside. By this means the contact of the ozone with the metals is avoided. The simplest form of ozoniser consists of an inner and outer tube, with one electrode inside the inner tube and the other outside the outer. The air or oxygen to be treated is passed through the annular space between the tubes.

So far we have been considering electrical currents only, and little has been said about electrical energy or electrical power. In electrolysis of water, for example, we have said nothing about the work done in decomposing, say, a pound of water into oxygen and hydrogen. As the quantity of electricity used varies as the quantity of water decomposed, the other factor, the pressure necessary to cause the decomposition must remain constant, and must be independent of the rate at which the electricity is passed, that is to say, of the current. Of course, there is extra pressure needed to overcome the resistance of the cell and connections, but that is lost; it is not converted into chemical work. The electromotive force necessary to produce electrolysis is of vital importance in commercial work. It is not necessarily proportional to the heat of combination of the radicles set free. This common error cannot be too often exposed.

Electrical power can be used in another way, namely, by locally heating a conductor to a very high temperature. The white-hot filament of an electric lamp is a good example. In its preparation it is heated electrically in contact with a hydro-carbon. This is decomposed, and carbon is deposited on the filament, which is then said to be "flashed" or "treated." The crater of the arc shows the highest temperature attainable with carbon electrodes. It has been pointed out by Prof. Silvanus Thompson that the crater rises to the temperature of volatilisation of carbon, and no farther; but the volatilising point of carbon is a very good temperature to reach. The uniformity of the temperature of the arc permits of an application of electricity to optics; in fact, it gives a standard of light. Prof. Thompson and the lecturer suggested this simultaneously, and the lecturer designed a screen standard. This has now been carried out practically by M. Blondel, and an account has been presented to the French Academy. Mr. Trotter and Prof. Thompson are also engaged on elaborate researches on the same subject.

The electrical furnace, like many other electrical inventions which are supposed to be quite new, was used by Sir Humphrey Davy nearly a century ago, and somewhat later by Staite, who used the arc furnace for obtaining fused iridium from its oxide for making incandescent lamps.

There are two varieties of the electrical furnace. The oldest is the arc form. A carbon crucible is used, and the arc is allowed to play on the inside from a carbon electrode. This form can hardly be employed on a large scale, but is convenient for laboratory work. The only commercial form is the Cowles, or incandescent electrical furnace. This furnace consists of a mass of carbon, with which the oxide to be reduced is mingled, and a pair of large carbon electrodes. The charge is rendered incandescent by the passage of an enormous current, and when it reaches a certain temperature, the oxide is reduced by the carbon. This furnace is used for reducing alumina. The aluminium is difficult to collect, and there is a large demand for aluminium bronze and aluminium iron, so these alloys are manufactured. Mr. Cowles also used his furnace for the reduction of silicon, chromium, boron, and other elements which are with difficulty reduced from their oxides. Mr. Cowles informed the lecturer some years ago that he found his furnace would reduce all the refractory oxides, but aluminium was the only product he considered of commercial value. Quite recently M. Moissan has reduced various refractory oxides by means of the Staite furnace; but it is only fair to Mr. Cowles to state that these results are quite old. This is not the case, however, with M. Moissan's most brilliant achievement, the production of black diamonds. To produce these a mass of iron is heated to a very high temperature by the arc furnace in contact with carbon. It absorbs a percentage of carbon. It is then cooled suddenly, and the contraction of the outside of the mass causes enormous pressure in the interior. The carbon which crystallises out in the centre is said to crystallise in the octahedral form, and, in fact, to be black diamond. The Cowles furnace is now used largely for the production

* A course of three "Tyndall" lectures at the Royal Institution.

of phosphorus from calcium phosphate, by a process invented by Messrs. Readman and Parker.

For experimental purposes the lecturer has devised an arc furnace in which the materials to be operated are not acted upon by the arc directly. A small carbon crucible with a carbon lid holds the material to be treated. It is placed between the tips of two electrodes. The current is started and the electrodes are moved apart so as to allow two arcs to play on the little crucible. This furnace will reduce uranium oxide, alumina, and other refractory oxides. If the electrodes are kept in contact with the crucible an incandescent furnace is obtained. The great advantage of this furnace is that it is easy to control, and that the charge does not get mixed with lime and cannot run away into cooler places in the furnace. The whole is held in a lime body. In another form designed by the lecturer, the crucible is the centre of two copper hemispheres, tinned and polished inside, with a pinhole for projection, so that the crucible can be watched.

[Experiments were made showing the softening point of carbon, the decomposition of hydro-carbon gases and liquids, the production and properties of ozone, and various sorts of electrical furnace were shown. The fusion of platinum, chromium, tungsten, and lime, reduction of uranium, and other refractory oxides were shown.]

LEGAL.

ELGOOD *v.* GENERAL ELECTRIC POWER AND TRACTION COMPANY, LIMITED.

THIS case, heard before Mr. Justice Grantham, on Friday and Saturday last week, was an action brought by Mr. Ernest Crawshaw Elgood, a member of Lloyds and a barrister, and his wife, against the General Electric Power and Traction Company, Limited, to recover damages for loss and injuries alleged to have been sustained through the negligence of the defendents' servant.

Mr. Lockwood, Q.C., and Mr. Elliott for the plaintiffs, and Mr. Waddy, Q.C., and Mr. Bremner represented the defendants.

On July 16th last the plaintiff and some friends attended East Moulsey Regatta, and returned down the river about half-past eleven at night in a punt, which was managed by a friend named Mr. Orlebar. They had passed through Hampton Court Bridge on the Middlesex side, and the punt had been turned across the stream with the object of discharging the passengers at the Castle Inn Wharf. When crossing they saw defendant's electric launch coming towards them; when first seen it was about fifty yards away. Mr. Orlebar at once called out to the man in charge of the launch, but he did not appear to take any notice; the punt was struck and capsized, and the party thrown into the water. They were rescued and had to pass the night at the Castle Hotel. Various picnic utensils and articles of clothing were lost, and Mrs. Elgood received a shock to her nervous system and an injury to her voice. Plaintiffs alleged that the accident was due to the negligent navigation of the defendants' launch. The claim amounted to about £25. The defendants denied that their servant had been guilty of any negligence, and contended that as the night was dark the plaintiff was negligent in omitting to have any light on the punt, or to give warning of its approach.

Mr. LOCKWOOD, after detailing the nature of the accident, said that he should endeavour to show carelessness on the part of the person in charge of the launch, who was about 19 years of age. He had not only to regulate the apparatus by which the electric force was applied or cut off, but had to regulate the speed and the course of the vessel, in addition to this he had to keep a look out.

Mr. Ernest Crawshaw Elgood, Mrs. Elgood, and Mr. Orlebar gave evidence in support of the plaintiff's case.

HERBERT WILSON, the principal witness for the defence, said he was in charge of the electric launch at the time of the accident. Had had an experience of four or five years on the river. At the time of the accident he had been in charge of an electric launch for two or three months; previous to this he had been on a steam tug. He was going at the rate of about three miles an hour. To manage the switches and steering gear he would be in the front part of the boat and would be looking ahead. Just before entering Hampton Court Bridge he saw a dark object shoot out in front of him. He immediately reversed, but could not prevent the collision. It would be impossible for two men to manage an electric launch similar to the one in question; there would not be room.

After the evidence of two or three watermen who heard the collision and helped to rescue the party, counsel addressed the jury.

The jury, after little consideration, found a verdict for the defendants, and his lordship gave judgment accordingly, with costs.

OBITUARY.

WE regret to announce the death of Mr. Walter T. Glover, senior partner in the well-known firm of W. T. Glover and Co., Salford, Manchester, electrical wire and cable manufacturers, which occurred on the 27th ult., at Northampton.

Mr. Glover, who was born in Salford in 1846, was formerly in the Manchester trade, but on the death of his father he took charge of his wire-covering business, and applied himself to its development. The introduction of the telephone, and subsequently of the electric light, enabled Mr. Glover to push his manufactures with energy and success, and the firm stands now in the foremost rank as manufacturers of insulated wires and cables of every class and description. The firm are contractors to the Post Office, to the railway companies, the National and other telephone companies, and also to various government departments at home and in the colonies. About five years ago Mr. Henry Edmunds joined Mr. Glover as a partner, and since that time and the establishment of central offices in London, the business has extensively increased.

It is a little over two years ago that we announced the death of Mrs. W. T. Glover, and at that time Mr. Glover was seized with a serious illness which incapacitated him from attending to business and from which he never recovered. He died, as we stated, on the 27th ult., at the early age of 46.

Mr. Glover was a Member of the Institution of Electrical Engineers, and was well known amongst the profession at all business and social gatherings. He was a member of the "Dynamicables" and subsequently of the Electro-Harmonic Society, at whose gatherings he was formerly a frequent visitor. Although an absentee for over two years from all technical and social meetings his face will be much missed.

The deceased was buried on Monday last at St. Paul's Kersal, Manchester, the funeral being attended by his relatives, by all connected with the firm, and nearly 200 of the employés.

NOTES.

Inglorious Photometry.—Looking once more at our leaderette of April 21st, we really cannot see that the slightest injustice was done to the distinguished inventor, as, from a communication to us, he seems to imagine. Indeed what we wrote was rather a criticism of the critics than a description of the instrument. Sir David Salomons is disappointed because his photometer does not strike the world as a practical thing. His ingenious elaborations are regarded as defects. To us they seem to introduce errors arising from the different powers of absorption for radiant energy of reflecting and refracting substances. From experiments which a friend has made on absorption, we cannot, without further proof, believe that nicols and screens can be made consistently with one another in this respect, however similar may be their dimensions. We should predict that each screen would have a different absorbing power, and that within each nicol a different amount of radiant stuff would be absorbed so that no two instruments would be identical or faithful. We venture to suggest that to demonstrate the accuracy of his photometer requires numerical proof; a series of numerical results made upon the same source of light by different observers, using the same, or different, instruments and standards. Such a series alone will vindicate the practicability of his invention. No such results are published; if there had been, we might have been spared the indignity of standing upon our editorial head in a public and metropolitan square while conjuring up "inglorious photometry."

Worcester Workhouse Electric Lighting.—It has been resolved by the Board of Guardians, on the recommendation from the Building Committee, that it is not advisable at present to introduce the electric light into the new workhouse.

Correspondence.—We have received too late for publication in this issue a letter on "Modern Gas and Oil Engines," one regarding the article which appeared in our issue for April 28th on "Cutting Down Prices," and a third on "Parks's Modification of the Wheatstone Bridge." We are therefore compelled to hold these over, to appear in next week's issue.

Private Bills in Parliament.—The City and South London Railway Bill was read a third time in the House of Commons on Tuesday last.

Personal.—Mr. Anthony Reckenzaun left by the ss. *Majestic*, White Star liner, on Wednesday last, 3rd inst., from Liverpool, bound for Philadelphia.

Dundee Electric Lighting.—It was reported at a recent meeting of the Finance Committee of Dundee Gas Commission that the application by the Commission for raising a further loan of £10,000 for the purpose of works under the Dundee Electric Lighting Order, 1890, had been agreed to by the Secretary for Scotland. The total amount authorised to be borrowed under the Order is thus raised to £30,000. The Treasurer reported that he had negotiated the loans representing the £10,000 for four years, at 3¼ per cent. The loans were approved of, and satisfaction was expressed by the Committee at the results of the application to the Secretary of State.

Sydenham Electric Lighting.—The inhabitants of Sydenham having presented a petition to the Lewisham Board of Works complaining of noxious vapours being emitted from the chimney of the electric lighting company, the Board have directed notice to be served upon the company for an abatement of the alleged nuisance.

Leicester Electric Lighting.—The Leicester Town Council has unanimously adopted the recommendation of its Gas Committee that it should apply to the Local Government Board for power to borrow £50,000, in order to exercise its power under the provisional order, and introduce the electric light. It has furthermore unanimously accepted the tender of the Brush Electrical Engineering Company, Limited, to provide an installation for a limited area in the centre of Leicester, at a cost of £27,587.

The Institution of Electrical Engineers.—On Thursday, May 11th, a paper will be read "On the Prevention of Sparking; Compound Dynamos without Series Coils or Magnets; and Self-Exciting Dynamos and Motors without winding upon Field Magnets," by W. B. Sayers, Associate.

Society of Arts.—At the nineteenth ordinary meeting, held on Wednesday evening last, a paper on "Practical Electrical Problems at Chicago" was read by Prof. Silvanus Thompson, D.Sc., F.R.S.

Edinburgh Telephone Wires.—The Corporation of Edinburgh having objected, says the *Financial Times*, to the right of the National Telephone Company to oppose their Improvements Bill, the question was last week considered by the Court of Referees. The Court decided to give the Telephone Company a right to appear in order to claim compensation for any interference with their wires affixed to buildings of which they are not the owners. This decision establishes an important precedent, as hitherto the mere fixing of wires to buildings did not give any claim to compensation when those buildings are taken down or interfered with.

Larne Electric Lighting.—The receiver and manager of the firm of J. E. H. Gordon and Co., Limited (in liquidation), some days ago wrote to the Larne Town Commissioners, offering the entire electric lighting installation for sale for £8,000, payable in cash, or, if preferred, in town stock. The working expenses of the installation he sets down as £300 per annum. The commissioners have decided that they will not purchase the installation on the conditions set forth. Judging from the spirit of the discussion at the meeting held on 27th ult., it seems that, whether the conditions offered are favourable or not, the installation will not at present be purchased by the local authority.

Hanley Electric Lighting.—The Hanley Town Council dealt, on Tuesday last, with the following recommendations from the General Purposes Committee:—"That 30 1,200-C.P. arc lamps, instead of 20 of 2,000-C.P. each, be provided for the purpose of street lighting, principally in substitution for the large gas lamps, as shown on the surveyor's plans; that the electric light mains be laid for the purpose of the street lighting by incandescent lamps at the same time as the other mains are laid, in order to replace the remaining gas lamps; and that an electrical engineer to have charge of the construction of the works of electric installation now being carried out for the borough, and to have the management of such works when completed, be appointed, at a salary of £200 a year, the person appointed being required to devote the whole of his time to the duties of the appointment. Canvassing to be a disqualification."

Award.—The Society of Engineers and Shipbuilders in Scotland have awarded their premium to Rankin Kennedy for his paper on "A New System of Electrical Distribution," being the best paper on electrical subjects read last session.

Worcester Electric Lighting.—The City Council are going to apply to the Local Government Board for a loan of an additional sum of £9,000 for the electric light generating station.

French Elmore Company.—The *Bulletin International de L'Electricité* contains some particulars regarding the reconstruction of the French Elmore Company. M. Secretan has circulated in France a letter soliciting subscriptions for capital amounting to 2,500,000 francs. Our contemporary states that works have been established at Dives for producing 300 tons of copper per month, with a manufacture at present of 30 tons.

Mining Institute of Scotland.—The annual meeting of this institute was held in the Hall at Hamilton last week. Mr. David Hunter read a paper on "An Electrical Pumping Plant at Bent Colliery," which elicited considerable discussion, and further consideration was adjourned. A Paper was also contributed by Mr. James Baird on "The Use of the Electric Light in Sinking Shafts."

Kidderminster Electric Lighting.—The two years allowed by the order in Council in which to adopt the electric light in the borough has only three months to run. An expert has been called in to advise the Corporation the best course to take, and his report will be laid before the Council next week. The general feeling, says the *Worcester Echo*, is averse to the Corporation carrying out the powers, and in favour of transferring them to one of the competing companies. Information is being obtained as to the number of persons who would take the new illuminant in the event of its being laid down.

An "Elastic" Contemporary.—We fully appreciate the respect which a certain contemporary—whose business it is to talk of India-rubber goods, and such like—pays to us, when the editor honours us with reproduction of our original notes, articles, meeting reports, &c., as has been done by wholesale of late, but we must confess that we should be more gratified if our contemporary would be so kind as to favour us, in future, with due credit for any matter considered by the editor of sufficient interest to India-rubber readers to warrant reproduction in the columns of that journal.

The Royal Society.—The following paper was down for reading before the Society last evening:—"On the Thickness and Electrical Resistance of Thin Liquid Films." Prof. Reinold, F.R.S., and Prof. Rücker, F.R.S.

Bristol Electric Lighting.—Things seem to be progressing favourably here. The *Bristol Observer* ventures to conjecture that the installation will be completed early next September.

Leeds Electric Lighting.—The new electricity works in Leeds of the Yorkshire House-to-House Electricity Company are to be opened by the Mayor of Leeds on Wednesday next.

Note for Visitors to Chicago.—The following is a copy of a letter, dated April 11th, 1893, received by Mr. F. H. Webb, secretary of the Institution of Electrical Engineers, from the American Society of Civil Engineers, and which was read out at the general meeting on Thursday last week. "In view of the probability that members of your society will visit this city *en route* to the Columbian Exposition, the American Society of Civil Engineers has appointed Edward P. North, L. L. Buck, and Foster Cronell a committee of information and courtesy at this house. This committee will endeavour to furnish all engineers, accredited by your society, with information as to rates, localities, and engineering works of interest. Please address such credentials, and all correspondence on this subject, to the Committee of Information and Courtesy, American Society of Civil Engineers, 127, East 23rd Street, New York City.—(Signed) F. Collingwood, *Secretary*."

Devon Electric Lighting.—The question of electrically lighting the new public offices is being considered.

Asylum Electric Lighting.—The advisability of lighting the Coxlodge Asylum by electricity has been considered by the Asylum Committee, who have resolved not to definitely decide regarding the question at present, although according to a resolution they have passed they "affirm the principle of lighting the asylum by electricity."

Burton Electric Lighting.—At a recent meeting of the Town Council, it was stated that £57,704 was required for the installation of the electric light in the borough. The contracts have been given to Messrs. Hammond and Co., of London, and Messrs. J. Fowler & Co., of Leeds.

Medical Battery Company v. "Science Siftings."—The Medical Battery Company have withdrawn proceedings against *Science Siftings*, and have paid £1,500 damages, including costs, on the counterclaim. The ground of action will be better understood if we refer to matters preceding our own lawsuits. It will be remembered that the solicitors of the Medical Battery Company issued, some time ago, a circular to the newsagents, which stated that if they sold copies of ELECTRICAL REVIEW and *Science Siftings* containing libels on their clients, they would be held responsible. Practically, the effect of the circular was to prevent many newsagents selling the papers in question. The matter was felt to be serious by us, and we at once commenced proceedings against the Medical Battery Company. The Medical Battery Company replied to this by serving us with a writ for libel, *Science Siftings* being served in a similar manner. A counter-claim was inserted in the pleadings of *Science Siftings*, damages being claimed on similar grounds to ours. The result of our action against the Medical Battery Company must be still fresh in the minds of our readers, and they will be pleased to learn that *Science Siftings* has practically proved its case without going into Court.

BUSINESS NOTICES, &c.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), is now ready, 784 pp. This standard work contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

Electric Light at Manchester.—The large arc light installation at the well-known Zoological Gardens, Belle Vue, Manchester, which consists of 67 lamps on 20 and 40 ampère circuits, and which have given so much satisfaction, and been so admired for their perfect steady working, is being increased by means of 100 ampère arc lamps. Messrs. Jenneson have again placed their order with Mr. A. W. Richardson, of Skew Bridge, Worsley Road, Patricroft. These lamps are of Mr. Richardson's differential clockwork type, the same as his ordinary current lamp, but of the lighthouse pattern, burning 40 mm. fluted carbons, the holders of which have universible adjustment. The dynamo which runs two of these large lights in series, and also incandescent lamps at the same time, is one of Mr. Richardson's latest designs, and is a combination of the most modern and best features, being a compound wound machine with inverted magnets, the cores of which, together with the pole pieces, are of wrought iron, machined bright throughout, and are fitted on brass packings, mounted on a massive bedplate which carries three bearings for the armature shaft. The armature of this machine is of the ring class, with core of Swedish iron washers thoroughly insulated, and which is mounted on a gun-metal centre. The commutator, which is mica insulated, is of a special mixture, and which after long experience and very severe tests gives most satisfactory results. This is fitted with double brush holders, which has a spring movement which allows a most sensitive adjustment. The machine runs continuously on full load without heating or sparking. The above powerful lamps, of which there are four, two duplicate ones being to illuminate the firework picture, burn absolutely steadily without flaring, giving a most brilliant and intense light. Mr. Richardson, we understand, is making a speciality of heavy current arc lamps, making them for any amount of current.

An Electric Crane.—An electric crane is to be erected on Southampton Town Quay. A few days since a deputation from the Southampton Pier and Harbour Board visited the works of Messrs. Stothert & Pitt, at Bath, and witnessed the testing of the crane; this was done with a weight of two tons, hoisting and slewing at the same time, and the trial proved in every way satisfactory.

Hotel Electric Lighting.—The "Kinloch Arms Hotel," Carnoustie, has been lighted by electricity by Mr. Joseph Anderson of that town.

Mica.—Messrs. Wiggins & Sons intimate that they have again obtained the Admiralty contract for the supply of mica.

A New Ceiling Rose.—We illustrate below a new ceiling (K.M.B. "Perfect") rose which has been designed by Messrs. King, Mendham & Co. It is made of china and consists of two parts, the plug and its cover, the latter constituting cover and base combined. The plug is divided into four parts by webs, and the terminals are fixed through these webs as shown in the illustration; an additional terminal is provided to carry the fuse. In wiring, the flexible cord is threaded through holes and knotted before being attached to the proper terminals, and the branch wires are brought through holes in the base of the plug. The advantages which Messrs. King, Mendham and Co., claim for this form of fitting are: 1. In fixing, the terminals are right in front of the wirer so that he has not to work up against the ceiling as he has when fixing the ordinary form, except when he is securing the cover to the block by the three screws. 2. A knot in the twisted cord is not required, which has hitherto been a very bad feature in these fittings, in wiring the plug of these fittings the knot is tied in each single stranded cord and this knot relieves the terminals of the weight of the lamp and shade. 3. There is no thread on these fittings to strip, and as the plug fits loosely into the cover, these parts are interchangeable and can be used promiscuously. 4.

From the design of the plug with its webs the fitting has a very high insulation, and no short-circuit can possibly occur from stray strands. The ceiling rose is therefore suitable for systems of any high voltage and for any position. 5. From the shape of the cover the fitting lends itself admirably to decoration. 6. The simple design of the two parts and the absence of a thread to cut render it very easy of production, so that it can be sold at a very low price.

Killarney Electric Lighting.—The laying of mains and erection of plant has been progressing rapidly for the last few months. A few days ago an experimental run of the plant was made, which was very successful. The company's central offices in the town were open to the public to view the lights; some electrical cooking apparatus was also shown in use. The high-pressure alternating current system has been adopted. The generating station is situated about a mile from the town, at the Flesk Mills, the water-power of the River Flesk being utilised. At present the existing Brest wheel is employed for the drive, and turbines are being erected, so that the driving machinery will be duplicated. The station contains two Mordey Victoria alternators, 2,200-volt, with direct-driven exciters. Trunk mains, laid underground in pipes, connect the generating station with the central switch station in the town, from which branch three H.T. circuits to the different parts of the town. Transformers are placed in pits in the street and feed into secondary networks for house supply. All the cable has been manufactured specially by the W. T. Henley's Telegraph Company, and subjected to a pressure of 5,000 volts. The company's engineer, Mr. Victor A. H. McCowen, has designed and carried out the scheme. The Killarney people are greatly pleased with the company's success, and orders are being received for the light.

Electric Light in Ireland.—The electric light is being introduced into all parts of the North of Ireland, one of the latest installations being at the residence of Mr. W. Young, Fenagh, near Cullybackey, where about 70 lights have lately been fitted. The current is supplied from the dynamo used for lighting the works of the Fenagh Finishing Company. The fittings for this installation have been supplied from the Belfast branch of the Edison and Swan United Electric Light Company, Limited, and the work has been carried out by Messrs. J. Ferguson & Co., of Ballymena."

Catalogues, Lists, &c.—Messrs. J. E. H. Andrew and Co., Ltd., of Reddish, have sent us a list regarding "Stockport" gas engines. The list is titled "Large Gas Engines *v.* Steam Engines for Producing Electric Light," and contains a report by Messrs. Andrews and Preece on an electrical installation at Morecambe, Lancashire, and a report by the chairman of the Newcastle Electric Lighting Company.

A new price list has been brought out by Messrs. P. Ormiston & Co., of Old Street, E.C.. The list deals with brass, copper, gutta-percha, insulated, and other wires.

W. T. Glover & Co.—The death of the senior partner of this firm is announced in another column. It occurred after a serious illness of over two years, which has necessitated his entire absence during that period. The business will be continued without interruption and carried on, as it has been during the late Mr. Glover's absence, by the surviving partner, Mr. Henry Edmunds, M.I.E.E., with the same management both in London and Manchester.

New Telephone Line.—W. T. Henley's Telegraph Works Company, Limited, laid a cable across the mouth of the River Tay, last week, for the National Telephone Company. The cable has 14 wires insulated with gutta-percha. Mr. Theophilus Smith, the well known telegraph engineer, carried out the work.

CONTRACTS OPEN AND CLOSED.

OPEN.

Brighton.—May 15th. Tenders wanted for supply and erection at the electricity works of a switchboard and apparatus. Further particulars will be found among our advertisements.

Canton.—May 6th. The Corporation of Cardiff is prepared to receive tenders for the erection of engine-house, boiler-house, and coal stores for the electric lighting station, Canton.

Killarney.—May 18th. The Governors of the Killarney District Lunatic Asylum invite tenders for the installation and supply of electric light to the asylum.

Manchester.—May 23rd. For the supply and erection of lighting and refrigerating machinery and plant complete, for the new stores and chill rooms about to be erected in Elm Street, adjoining the abattoirs, Water Street, Manchester.

Mortlake.—May 23rd. For providing and fixing the necessary apparatus for lighting their works at Mortlake by electricity, for the Richmond Main Sewage Board.

Salford.—May 11th. For erection of the buildings required at their electric light generating station, for the Gas Committee.

CLOSED.

Aberdeen.—The Gas Committee of the Town Council have decided, subject to the approval of the Council, to accept the following tenders for work in connection with the electric lighting installation:—

	£	s.	d.
Mason work—Mr. R. Smith, Aberdeen	1,744	0	0
Plumber work—Messrs. J. Blaikie & Sons, Aberdeen	77	0	0
Concrete work—Messrs. M'Farlane, Leeds ...	447	0	3
Painter work—Messrs. J. & S. Fyfe, Aberdeen ...	63	0	0
Carpenter work—Messrs. Watson & Robb, Aberdeen	351	0	0
Slater work—Messrs. M'Gregor & Shand, Aberdeen	92	5	8
Iron roofs—Messrs. M'Kinnon & Co., Aberdeen ...	410	0	0
Iron battery stands—Messrs. M'Kinnon and Co., Aberdeen	56	0	0
Engines, dynamos, &c.—The Electric Construction Company	5,044	0	0
Switchboards—Simmons & Co. (Siemens ?) ...	990	0	0
Boilers—Babcock & Wilcox	1,494	0	0
Street excavations, concrete, culverts, &c.—Scott and Sellar	2,671	0	0
Batteries—The Electric Power Storage Company	760	0	0
Copper strips (the quantity being estimated at about 30 tons)—Bolton & Schedle, Staffordshire ...	1,820	0	0
Cables—Callender & Co.	1,532	0	0
Pilot wires—The British Insulated Wire Company	190	0	0
Insulators—Doulton & Co.	177	0	0

The total contracts, including the buildings, amount to £17,918.

Leicester.—The tender of the Brush Company has been accepted for the electric light installation, at the figure of £27,587.

CITY NOTES.

Submarine Cables Trust.

THE report of the trustees to the twenty-second ordinary annual meeting of the certificate holders, held at the offices of the Trust, 50, Old Broad Street, yesterday, May 4th, reads as follows:—

"The accounts for the financial year, to April 15th, 1893, are submitted herewith. The revenue for this period, including the balance of £159 13s. 3d. brought from the previous accounts, amounted to £23,261 13s. 11d. During the past year the following coupons have been met:—

Due.	Paid.
April 15th, 1892 ...	£1 17s. 6d. balance August 2nd, 1892.
October 15th, 1892 ...	£1 10s. on account October 15th, 1892.
	£1 10s. balance February 7th, 1893.
April 15th, 1893 ...	£1 10s. payable April 15th, 1893.

The expenses of the Trust amounted to £1,627 13s. 2d., and the payments on account of the coupons to £21,553 17s. 6d., together £23,181 10s. 8d., leaving a balance of £80 3s. 3d. to be carried forward. A table showing the original and present investments of the Trust is appended to the report. It remains unchanged since last year. It is with regret the trustees have to record the death of their secretary, Mr. William Payton. They have appointed as his successor Mr. A. Brodrick. The meeting will have to elect two auditors for the current year; Mr. John G. Griffiths and Mr. John Gane offer themselves for re-election."

The meeting was of a purely formal character, the CHAIRMAN briefly referring to the items mentioned in the report and accounts. He hoped, if the dividends continued good this year, that they would pay off the arrears on the overdue coupon. One of the certificate holders had written to him, commenting on the appointment of new trustees, but they were bound by their articles of association to replace those who were removed by death. The success of the trust depended entirely on the successful working of the different submarine cable companies, in which they had investments. At the present moment they were in a very satisfactory position. The trust was a sort of tontine business, and those who lived longest would eventually possess the whole thing. He hoped for increased prosperity, and in conclusion moved the adoption of the report.

West Coast of America Telegraph Company, Limited.

THE sixteenth ordinary general meeting of this company was held on Tuesday last, May 2nd, at Winchester House, E.C., Mr. James Denison Pender presiding.

The SECRETARY (Mr. F. L. Robinson), having read the notice convening the meeting,

The CHAIRMAN, in moving the adoption of the report and accounts for 1892, stated that the large decrease in the gross receipts of the company, as they were aware, was owing to the fact of the cable and land lines having been practically isolated from the outside world, and the traffic almost confined to local works at reduced rates, consequent upon the competition of the American Company at Lima, Santiago, and two other places, which were their principal stations. The receipts had also been affected by the continual depreciation in the value of the currency. On the other hand, their atttenion had been drawn in the report to the reduction in the gross expenditure of about £2,500, as compared with the previous year. That reduction was attributable to economies effected on the West Coast, and to the comparatively small cost of maintenance of the cables and land lines, notwithstanding that this item included the greater part of the reconstruction of the land lines between Valparaiso and Santiago, and the expenses connected with taking over new and other commodious premises at Valparaiso. That was rendered necessary on account of the Pacific and European Company, which would go into this company's offices there. During the year the cables were only interrupted on two occasions; a fault appeared in the shore ends at Iquique, in June, and in the northern section between Molenda and Lima was broken by an earthquake in November; the necessary repairs in each case were promptly effected by their repairing steamer *Retriever*. The steamer was stationed at Callos, and was kept in the highest degree of efficiency. One of the most important works that had been carried out by the company during the twelve months was the extension to Talcahuano. That matter had received the earnest attention of the board for some time past; customers on the West Coast required a more reliable service between Valparaiso and Concepcion than that at present in existence. The only communication between those two places was a round-about-way by the land lines. The new cable would run direct. The extension was also urged by the late Chilian Minister; a concession was therefore secured from the Chilian Government to lay a land line. That was just completed, and a cable of the improved type was shipped to Talcahuano in February last. From the sailing vessel which carries it out, it will be transferred to the company's steamer *Retriever*, and laid under the superintendence of Mr. Bailey, their superintendent there, and the captain of the ship. As to the possible earning power of the extension, they were advised from Valparaiso that they would have a very considerable amount of traffic over that line. That line would give them plenty of business. The principal Valparaiso firms sent more telegrams to the South than to any other part of the coast, and, with a good, reliable service, they were assured that the present amount of telegrams would be trebled. At the last general meeting they were informed that negotiations with the Brazilian Submarine and Western and Brazilian Telegraph Company, conducted under the presidency of Sir John Pender, had resulted in the formation of a new company, the Pacific and European Telegraph Company, the share capital of which is held by the Brazilian Company and the West Coast of America Company. The duplicate lines to be run by the new company from Buenos Ayres to Valparaiso and Santiago were approaching completion, and would be taken into the company's office at Valparaiso, and the working expenses at two or three stations will be paid partially by this company and partly by the new company. After some lengthy remarks regarding the past history of the company, the chairman went on to speak of the future, to show them that the West Coast of America company will shortly be in a better position than ever. For this new line, the debenture interest was guaranteed by the Brazilian Submarine, also by the West Coast Company, and the Western Brazilian had also something to do with it. Therefore they were not only bound up to them by working agreements, but they were bound to them also financially, which perhaps made a stronger bond than any other. He was not going to prophesy as to the future; he had simply given them the position, and would leave them to form their own opinion about it; his opinion of the West Coast of America Company was that that it is now, perhaps, on the eve of a better position than it had ever been before. He then formally moved "That the report and accounts for the year ending December 31st, 1892, now presented, be received and adopted."

Mr. HENRY ROBERTS seconded the motion.

The retiring directors, Mr. J. Denison Pender and Mr. Frederick Walters, were re-elected; also the auditor, Mr. John Francis Clarke.

Indo-European Telegraph Company, Limited.

THE twenty-sixth ordinary general meeting of this company was held on Friday last, 28th ult., at Winchester House, E.C., Mr. J. Herbert Tritton presiding.

The managing director (Mr. W. Andrews) having read the notice convening the meeting, also the minutes of the previous meeting,

The CHAIRMAN, in moving the adoption of the report and accounts, stated that there was very little to be said upon the report of the.

company for the last year. It would perhaps be as well for him to draw their attention to the total of the expenses account under maintenance in the revenue accounts. Expenses and charges to 31st December were £30,188. That apparently showed an increase, which, however, arose from their having written down the costs of certain plant and apparatus, for which they thought the year offered a favourable occasion. The policy was merely a continuance of former measures in the same direction, only the sum to be dealt with was rather larger. As a fact the actual working expenses showed a decrease—a slight decrease. There were increases under the heads of salaries and wages, and for station expenses and travelling connected with the message departments, &c., and diminutions under other heads. The revenue in the aggregate showed an increase of about £700, having added the amount brought forward to the gross revenue, which amounted to £17,479, and crediting £10,000 as placed to the reserve, deducting the interim dividend paid, there remained a balance of £39,432 16s. 11d. available; that, as they had heard from the resolution and had read in the report, the directors proposed to employ by declaring a dividend for the past six months, ending December 31st, of 17s. 6d. per share, making, with the dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent., and carrying forward £7,557 16s. 11d. to be credited to 1893. That was practically the outcome of the year's working. He had no doubt they would agree with him that it was a very satisfactory one indeed. The gross receipts for Indian business were still below those of the year 1886, when the reduction was made in the tariff, although the number of words was greater. The fact appeared to be that in an old country like India there was a very different state of things to that of younger and rapidly growing communities. There might be and of course were fluctuations or periods of greater or lesser activity, but the rapid growth all round was distinctly wanting. The reduction of tariffs made with Australia had made a very large augmentation of the number of words transmitted, and it was not too much to assume that if the reduced tariffs had been left alone the former rate of revenue would have recovered in a few years. An addition of 9d. per word was made to the lowered tariff rate, in order to get not all but some of the loss sustained by the reduction back again. They hoped by-and-bye that this small addition would be knocked off. After referring to the pause in the advance of the great Australian colonies, which they were at present witnessing, he said that the lines of the company were working most satisfactorily. Shareholders should not in his (the chairman's) judgment, fail to remember that prosperous as the company was, there were yet contingencies which must be reckoned with in estimating the position and the future of the company. It gave him much pleasure to be the mouthpiece of the board of directors in moving the resolution, which was as follows:—"That the report and accounts now submitted be received and adopted, and that a dividend be and is hereby declared for the half-year ending December 31st, 1892, of 17s. 6d. per share, making with the interim dividend already paid, 6 per cent. for the year, and a bonus of 20s. per share, both free of income tax, making in all 10 per cent. for the year."

Mr. HENRY WEAVER seconded the motion, which was unanimously carried.

The retiring directors, Messrs. C. W. Earle and C. Holland, were re-elected, as were also the auditors, Messrs. C. F. Kemp, Ford & Co.

The usual vote of thanks to the chairman and directors closed the meeting.

Elmore's Patent Copper Depositing Company, Limited.

THE following is dated April 12th, and signed by Mr. Shurmer, the secretary, and by Mr. J. Todhunter, the chairman of the committee, and is sent out with the prospectus offering 8,805 10 per cent. cumulative preference shares:—

"The above issue of preference shares for working capital is made in pursuance of the joint recommendation of the directors and of the investigation committee of the shareholders—Messrs. J. Todhunter, G. Inverarity, A. Pritchard, J. Webster, and J. Y. Davidson, M.I.C.E.—whose report to the shareholders, dated March 29th last, has been issued and adopted in general meeting held on the 7th inst., when the following resolution was unanimously passed:—'That the committee of the shareholders of this company, consisting of Messrs. J. Todhunter, A. Pritchard, W. S. Squire, and Owen Jones, be continued as a consultative committee, to co-operate with the present board in making an issue of the new capital referred to, with power to accept the resignation of all or any of the present directors, and, in conjunction with the present directors, to nominate new directors, and generally to advise the board and report to a future meeting to be called on the 28th instant.' The directors and committee believe that the needs of the company's business will be fully met by the proceeds of the present issue, and the committee in their report say:—'We are strongly impressed with the value of the business, and advise that a strong effort should be made to provide the means for carrying it on. . . . This being done, we think that a satisfactory and profitable business will be quickly established, with, as a result, the reinstatement of credit, and clearing away of future difficulties.' The committee report that 'we saw tubes in every stage of manufacture, and they appeared perfect in every way. We examined into the orders received and those executed, and we were gratified in finding that customers come again with frequency, and that there seems always a sufficiency of orders on the books for more than the present output;" indeed, there is every reason to believe that the maximum output of the present plant, namely, 20 tons a week, can be readily sold at a handsome profit. The present issue of capital will, it is believed, be ample to enable the company to reach this output. There can be little doubt, therefore, that the preference shares are certain to earn the cumulative 10 per cent. dividend, to which they are entitled, while the assets of the company are ample as regards the security of the preference capital they represent. It is intended as quickly as possible to appoint a small but strong board of directors, consisting of men of good business capacity, and a general meeting will be held on the 28th inst. to approve and confirm such appointments, and the present subscription is invited subject to such approval and confirmation. Accordingly the subscriptions will be paid into a separate trust account, in the names of Mr. J. Todhunter and Mr. A. Pritchard, and no allotment will be made until the arrangements have received approval of the shareholders in general meeting on the 28th inst. It is exceedingly desirable, however, that applications for the shares should be made at once, as it is impossible to nominate a new board until it is seen that the necessary working capital is forthcoming, it being obvious that no man of business would join in the absence of complete assurance on this point. In the event of the present issue being over-applied for the allotment will be made to the shareholders in proportion to their present holdings. The Companies' Acts require that the dates and names of the parties to all contracts relating to the company should be set out, but with a going concern this is obviously impossible, and applicants for shares must waive compliance with the 38th Section of the Act of 1867, or otherwise, and any allotment will be made subject to such waiver. Applications for shares should be sent promptly on the enclosed form, accompanied by the deposit of 5s. per share, either to Brown, Janson & Co., 32, Abchurch Lane, E.C.; or to the secretary of the company, at 64, Cannon Street, E.C."

The adjourned extraordinary general meeting of this company was held at Cannon Street Hotel on Friday last, Mr. J. J. Atkinson presiding.

At the commencement of the meeting a shareholder asked when the meeting of the American Elmore Company would be held. He was told at the last meeting that it should be called in four weeks, three of which had now passed without notice of the meeting having been sent out. The shareholders in the American Company could get no satisfaction whatever from the board.

The CHAIRMAN, in reply, stated that the secretary was not in London, but the meeting would be called as soon as the accounts were ready. Proceeding to the business of the present meeting, he said, "This being an adjourned meeting there was no notice required, but it was adjourned at the last meeting held on the 19th inst., to allow a committee in conjunction with the board to collect subscriptions to enable the company to be carried on for the shareholders. The committee were to receive the resignations of the late directors. I am here to-day to tender the resignations of the late entire board, and to say that the gentlemen who were proposed under certain conditions to act as a new board at the request of this meeting, are Mr. Todhunter, Mr. Owen Jones, and Mr. J. W. Dale. They are part of the committee appointed by ourselves at the last meeting and are the only ones that have been enabled to remain as directors. It is for you to ask them to act and to fulfil the conditions they impose. I think it will be much more satisfaction to you to hear their report and what their policy is from one of themselves than if I said anything more. Mr. Todhunter, who is their chairman, will now address you.

General BEADLE (a shareholder) here asked whether before the old directors resigned, they were prepared to replace the half-premium which, by the prospectus of the Wire Company, was to be put to the reserve fund. Half the premium under the prospectus was to be placed to a reserve fund. There ought to be sufficient money to carry on if that money was put back. It was expressly separated from the capital, and it would be necessary to go into that point if the money was not forthcoming.

Mr. TODHUNTER (Chairman of the new board), said he believed they were all present when on a former occasion he was appointed with two or three other gentlemen as the continuation of a committee to consult with the directors as to what was to be done for the carrying on of the company's business. They met and conferred with the directors and became perfectly aware after a short time that it would be absolutely useless to ask the shareholders to go on or to find more money for this company if any of the original directors managed on the direction of the affairs of the company. It then became necessary to consider the first of their recommendations, which was, that a local board of men of business capacity should be appointed. He need hardly state that under the condition of affairs it was the most difficult thing to approach any local men of position to ask them to take the direction of a company which was practically upon its last legs. They had no acquaintance really with Leeds people and were unable to make any enquiries except at second hand, and those enquires seemed to prove to them that it would be perfectly futile to endeavour to find any gentleman in Leeds of sufficient ability and business capacity to manage the affairs of the company. They therefore had to say to the directors that they did not see their way to fulfil the first recommendation which had been given by the committee, and therefore the only way was to endeavour to seek somebody in London who would undertake the duties. There they met with some difficulties; they approached several people, and they at once said "Oh no! we will have nothing to do with this company," and so it remained; they were placed in the very singular position that they could make no recommendations to the shareholders unless they themselves—some of them—undertook the very onerous duties of the management of the affairs of the company. They were all exceedingly reluctant to do that; he himself spoke very feelingly in the matter, and had the greatest reluctance to having anything to do with the affairs of a company which had been brought into the position which this company was now in. But they were so urgently pressed by the late directors, and by some of the very largest of the shareholders, that they had consented to take the direction of the affairs under certain conditions. In the first place, before they would act, the

capital required to carry on the two companies (English Patent Company and the Wire Company) which were so closely combined that it was difficult to separate them, must be subscribed up to the hilt, or they would have nothing to do with it. They believed that the subscription of the remaining shares as preference shares in the Depositing Company would fulfil those conditions; if the 8,800 shares remaining were issued as 10 per cent. preference shares, and fully subscribed there would, they believed, be sufficient money to carry on the works of the Depositing Company. They must have the most of the capital—£25,000 in debentures—subscribed for the Wire Company. He still believed in the process, and that they had a business which should not be thrown away. The new board could not promise to work without fees, but they did not intend to take £3,000 a year, which was what the retiring directors had received for three years. For the first twelve months they proposed to draw £750, and at the end of that time they would leave themselves in the hands of the shareholders. In conclusion he stated that unless the £17,600 required to carry on the depositing copper, and £25,000 for the Wire Company was forthcoming, the companies must go into liquidation.

General Beadle, in a lengthy speech, strongly attacked the past management of the Copper and Wire Companies. He should like the minute book of the board to be carefully investigated, and he thought it might be desirable that a Board of Trade inquiry should take place in connection with the prospectuses of the companies, and the way in which the shareholders had been treated.

The Solicitor (Mr. Hays) said that wherever he went he heard the Elmore copper process spoken of in high terms. He wished to impress upon the shareholders that unless the money asked for was forthcoming the mortgagors would foreclose and seize the property. To allow that to be done would be a great mistake, because the Copper Company had land which, if they nursed, was worth half their capital. He quite approved of the suggestion that the committee should investigate to the bottom the misdeeds of the past management and make the original directors pay back any money it might be possible to make them liable for.

Mr. J. W. Dale (one of the proposed new directors), said he had not sought a seat on the board, and his only object in joining it was to do his best to bring the company round, believing as he did in the Elmore process. Unless they made up their minds to subscribe for the preference shares, they must make up their minds to lose their property. He might add that if the shareholders in the Wire Company subscribed £10,000 on second debentures, it might be possible to raise the balance of £15,000 by mortgage on the property.

The Chairman said he did not wish to shirk responsibility. In fact he courted it, and he added that he still fully believed in the Elmore process.

On the motion of Mr. Hays, seconded by Mr. Todhunter, J.P., it was decided:—"That this meeting be adjourned for 14 days, and that in the meantime a circular be sent out giving the names of the gentlemen willing to take office as directors, provided that the 8,800 preference shares in the interval are fully subscribed, and upon the understanding that if the shares are not fully subscribed in the meantime, any money paid be returned."

Elmore's Wire Manufacturing Company, Limited.

The following report, dated April 12th, is signed by Mr. Shurmer and Mr. Todhunter, and is sent out with the prospectus offering the issue of £25,000 of first mortgage debenture stock, bearing interest at 6 per cent. per annum:—"The above issue, being the first part of a total creation of £50,000 of six per cent. first mortgage debenture stock, is made in pursuance of the joint recommendation of the directors and of the investigation committee of the shareholders—Messrs. J. Todhunter, S. W. Gore, A. Pritchard, J. Webster, and W. R. Biddell—whose report to the shareholders, dated March 29th last, has been issued and adopted in general meeting held on the 7th inst., when the following resolution was unanimously passed:—'That the committee of the shareholders of this company, consisting of Messrs. J. Todhunter, A. Pritchard, W. S. Squire, Owen Jones, and J. W. Dale, be continued as a consultative committee, to co-operate with the present board in making an issue of the new capital referred to, with power to accept the resignation of all or any of the present directors, and, in conjunction with the present directors, to nominate new directors, and generally to advise the board and report to a future meeting, to be called on the 28th inst.' The directors and works managers, who are the largest individual shareholders of the company, are convinced that with the necessary working capital found the company will be perfectly successful. The committee in their report say: 'We believe there is no doubt at all about the efficacy of the process, or that the difficulties of manufacture have been overcome, and we think that there is a demand for the copper strip produced, at a highly remunerative price, if the production is on a large scale. We certainly believe that there is every prospect of success under prudent management.' Mr. Owen Jones, C.E., who assisted the committee in their investigation, reports:—'I cannot help expressing my belief and conviction that it (the Elmore process) is of great value, and that if judiciously and economically managed the manufacture of copper wire (strip) would be a success, and remunerative to your company.' The works are now capable of turning out 30 tons of copper strip and sheet a week; a small further expenditure on plant is requisite on the score of economical working, but an immediate output and sale of that quantity need not be delayed on this account. The proceeds of the present issue will be sufficient to clear off the whole of the company's liabilities and leave a balance in hand, and in this event the board and the committee have reason to believe that the company can obtain, on advantageous terms, all the raw copper it requires for its manufacturing purposes. With a competent board of directors, and the company's credit re-established, there can be no difficulty under this head. The directors and the committee cannot too strongly urge upon the shareholders the necessity and desirability of at once subscribing the amount of the present issue, and in this connection quote the following resolution, which was unanimously carried at the general meeting held on the 7th inst: 'That this general meeting of the shareholders of Elmore's Wire Manufacturing Company adopt the report of the committee of the shareholders, dated March 29th, and unanimously recommend the shareholders of the company, in view of the evident commercial success of the Elmore process, to promptly subscribe the new capital required, on such terms as the committee may recommend.' The Committee are unanimously of opinion that there is good security in the freehold land, works and plant for the amount of the present issue of debenture stock, even in the event of the company's failure. The stock will be issued under the powers in that behalf contained in the company's memorandum and articles of association, and with the benefit of, and subject to, the conditions endorsed on the enclosed form of application, and will rank *pari passu* and be secured by a conveyance of the whole of the company's freehold land and buildings to trustees for the holders of such stock and charged by way of floating security upon the whole of the company's plant and machinery (but excluding the copper in process of manufacture and the book-debts representing the sale thereof), the value of which, as shown by the company's balance-sheet, dated October 31st, 1892, is the sum of £90,764 3s. 7d., exclusive of the value of the licenses. It is intended as quickly as possible to appoint a small but strong board of directors, consisting of men of good business capacity, and a general meeting will be held on the 28th inst., to approve and confirm such appointments, and the present subscription is invited, subject to such approval and confirmation. Accordingly the subscriptions will be paid into a separate trust account, in the names of Mr. J. Todhunter and Mr. J. W. Dale, and no allotment will be made until the arrangements have received the approval of the shareholders in general meeting on the 28th inst. It is exceedingly desirable, however, that applications for the stock should be made *at once*, as it is impossible to nominate a new board until it is seen that sufficient funds are forthcoming to meet the liabilities of the company, it being obvious that no man of business would join in the absence of complete assurance on this point. Applications for stock should be sent promptly on the enclosed form, accompanied by a deposit of £5 per cent., either to Brown, Janson & Co., 32, Abchurch Lane, E.C., or to the secretary of the company, at 64, Cannon Street, E.C."

"To the Shareholders:—The board and committee of the shareholders regret to inform you that no practical response has been made to the recent issue of £25,000 of 6 per cent. first mortgage debentures; but, at the same time, I am instructed to say that the liabilities of the company due to unsecured creditors (exclusive of the £11,000 secured to our bankers) have been reduced to under £5,000; it is, however, evident that unless this sum of £5,000 is promptly provided, a receiver will have to be appointed, very greatly to the prejudice of the shareholders. The directors and the committee therefore strongly urge you to co-operate with them in finding the amount required, namely, £5,000, which will be secured by 6 per cent. mortgage debentures, redeemable at 5 per cent. premium, part of an issue of £10,000 charged on the company's entire property, subject only to the prior charge of £11,000. If the shareholders carry out this recommendation they will retain the valuable property of the company in their own hands, thus giving the new directors, when appointed, time to raise the larger sum required, when the present temporary issue would be paid off or exchanged into the new at the option of the debenture holders. Should the present necessary sum not be forthcoming on or before the 27th inst., it will only remain to pass a resolution to wind up the company, a course which your committee, in view of the satisfactory prospects of the company set out in their report and prospectus, unanimously consider would be most unwise and imprudent under the circumstances. You are therefore asked to fill up and send to me the enclosed form of application for the amount of the debentures you are prepared to subscribe.—J. Shurmer, Secretary."

Immediately at the close of the meeting of the Elmore's Patent Company last Friday, the meeting of the Wire Manufacturing Company was held, Mr. J. J. Atkinson again presiding. The same resolution as was passed at the Patent Company's meeting (and will be found in another column) was carried unanimously here, and the meeting terminated.

Elmore's German and Austro-Hungarian Metal Company, Limited.

The directors' second annual report and statement of accounts for the year ending December 31st, 1892, reads as follows:—"Your directors beg to submit herewith their report and statement of the company's accounts for the year ending December 31st, 1892, duly audited. The auditors have also attached a statement based on the balance-sheet of Elmore's Metall Actiengesellschaft which had been duly certified by the auditors in Cologne, for the period commencing with the formation of that company, viz., October 7th, 1891, to December 31st, 1892.

The balance-sheet of this company shows but little alteration from that published last year beyond the payment of the second instalment upon the Schladern property, and that £2,000, has been advanced to Elmore's Metall Actiengesellschaft by way of loan. As stated in the last report, the holders of the debentures (except as to £1,100) have agreed to take preference shares to the amount of debentures held by them, and although the exchange has not yet taken place, the interest ceased (with exception of that upon the £1,100) on July 7th, 1892.

The directors are using their best endeavours to get the exchange effected at an early date. The balance-sheet of Elmore's Metall Actiengesellschaft shows that the work done was chiefly in completing the factory, the manufacture of mandrels, and carrying on various trials. As stated in our circular of the 13th ult., much experimental work had to be done to satisfy probable customers; of this we are now commencing to reap the benefit. The circular addressed to you on March 13th last placed the position of the company very frankly before you, and your directors have but little to add to that circular beyond bringing the facts up to date. Mr. Rock, the chairman of this company, and General Fraser, in their respective capacities as chairman and board of management of Elmore's Metall Actiengesellschaft, attended the general meeting of that company, held at Cologne on the 11th inst. They subsequently visited the factory at Schladern, and found the works in a satisfactory condition. They are convinced from the reports they have received, and from their own observations, that all mechanical difficulties are overcome, and that there is nothing to prevent a constant and regular output. They were also pleased with the state of efficiency observable in the works, and are confident that, with sufficient funds, the company will prove a success. The order book showed that over 130 orders had been received for various classes of work, many of which are repeat orders from prominent firms in Germany. One firm has just now ordered 47 tubes, another 150 feet of tubes, and another 18 tubes. An order from the German Admiralty has been executed, and a further order is now in course of execution. Large orders may be anticipated in the event of the trials which the Admiralty are making proving successful, a result which there is little doubt will be obtained. These orders show that the Elmore process is becoming known in Germany; but, as with all new inventions, it has to be tried and tested before large orders are placed. Owing, however, to the present want of funds to push the sale by advertising, &c., sufficient orders have not yet been obtained to fill all the tanks; but there is no doubt that so soon as the trade generally is convinced of the superiority of the Elmore process, as carried on at the company's works, there will always be sufficient orders to keep the tanks fully employed. The directors are also glad to state that the compound mandrel mentioned in the circular of March 13th is fulfilling their anticipations. As to finance, the issue of the 7 per cent. preference shares offered in the circular of March 13th was unfortunately not responded to sufficiently to allow of the directors going to allotment, and the money subscribed was therefore returned. The directors much regret the failure of this issue, as with the sum of £15,000 thus raised, the company would have been placed on a sound financial basis, without debts, and with a splendid property absolutely without encumbrance, and it would also have permitted a further 40 tanks to be added when required, and still leave a sufficient sum in hand for working capital. The directors now propose to arrange for a charge to be created upon the property at Schladern up to an amount not exceeding £15,000, which will be offered to the shareholders for subscription, and being secured upon a valuable freehold property, will be a safe investment. The directors are pleased to state that the vendor of the Schladern property has consented to allow the payment of the final instalment to stand over until November 4th next, to enable the directors to raise the necessary funds. Summing up, the directors consider that as regards manufacture, the company in Germany is a success, and although its present output is small, they are confident that by persistent energy in pushing the business, full commercial success will be attained. The directors wish to emphasise the fact that the business is being worked under exceptionally favourable conditions. First, the water-power is a great economy, no coals having been required for other than heating purposes. Second, the wages are low, only averaging 15·7 marks per employé per week, including foremen. Third, the factory is situated in the busy part of industrial Germany, and is not more than 300 yards from the Schladern Railway Station. The directors have always used befitting economy in all their dealings, and they trust the shareholders will agree with them that a great deal of work has been done with limited means; but it is obvious that unless further funds are immediately provided, the business cannot be continued, and a fine property and undertaking will be sacrificed. The retiring director on this occasion, Mr. J. Rock, being eligible, offers himself for re-election. The auditors, Messrs. Cooper Brothers and Co., also offer themselves for re-election.

BALANCE SHEET, December 31st, 1892.

Dr.	£	s.	d.
To Capital authorised—100,000 shares of £2 each ...	200,000	0	0
To Capital issued—75,000 shares of £2 each, £150,000; less instalments in arrear, £2,764 15s.	147,235	5	0
„ Premium on 50,000 shares, £25,000; less amounts in arrear, £497 10s.	24,502	10	0
„ 6 per cent. mortgage debenture stock charged on the undertaking of the company, redeemable on or before January 7th, 1898, at 105 per cent., £50,000; less amount redeemed at 80 per cent., £3,098 19s. 3d. ... ... (The holders of £45,801 0s. 9d. of this stock have agreed to accept preference shares in exchange for it.)	46,901	0	9
„ Creditors—Balance due on purchase of land, &c., in Germany, payable on May 4th, 1893, with interest, £7,222 12s. 6d.; debenture interest accrued to July 7th, 1892, and £33 to January 7th, 1893, unpaid, £1,292 3s. 8d.; general accounts in London, £617 14s. 10d.	9,132	11	0
	£227,771	6	9

Cr.	£	s.	d.
By Cost of Elmore's patents for Germany, Austria and Hungary, as last year, £175,000; less license to Elmore's Metall Actiengesellschaft, £10,000	165,000	0	0
„ Elmore's Metall Actiengesellschaft—1,000 shares of £50 each, fully paid	50,000	0	0
„ Bills receivable from Elmore's Metall Actiengesellschaft	2,051	4	0
„ Cash at bankers and in hand	1,144	17	1
„ Sundry debtors	26	15	10
„ Furniture and fixtures	59	9	0
	218,282	5	11
„ Preliminary expenses	952	7	1
„ Interest, as at December 31st, 1891, £2,401 5s. 10d.; by debenture interest, for half-year to July 7th, 1892, and £33 to January 7th, 1893, £1,511 4s. 9d.; by balance of general interest account, £33 19s. 1d.	3,946	9	8
„ General administration charges—As at December 31st, 1891, £2,845 1s. 10d.; directors' fees, agency and salaries, £1,747 10s. 6d.; patent charges, law costs and auditors' fees, £302 15s. 5d.; rent, rates and taxes, printing and stationery, postage and telegrams, advertising and sundry office expenses, £331 7s. 2d. = £2,381 13s. 1d.; less transfer fees, £16 15s.; rebate on debenture stock, redeemed at 80 per cent., £619 15s. 10d., £636,10s..10d. = £1,745 2s. 3d.	4,590	4	1
	£227,771	6	9

We have examined the above balance-sheet with the books and accounts kept in London, and find it correct. The accounts of the business in Germany are kept there, and we have seen a balance-sheet received from Germany, signed by two local auditors.

COOPER BROTHERS & Co., Chartered Accountants } *Auditors.*

London, *April 24th*, 1893.

BALANCE SHEET, December 31st, 1892.

Based upon Accounts audited in Germany (exchange at 20 marks to the £1).

Dr.	£	s.	d.
To Share capital—1,000 shares of M. 1,000 each ...	50,000	0	0
„ Bills payable to Elmore's German and Austro-Hungarian Metal Company, Limited	2,051	4	0
„ Sundry creditors	696	5	4
	£52,747	9	4

Cr.	£	s.	d.
By Cash at bankers and in hand	694	18	1
„ Sundry debtors	164	14	8
„ By Stock-in-trade, raw materials, mandrels, manufactured goods, and sundries	4,248	10	2
„ Office furniture	131	14	9
„ Patents	10,000	0	0
„ Plant, machinery, &c.	8,430	1	6
„ Schladern Works account—Land, buildings and water-power	24,605	13	4
	48,275	12	6
By Establishment expenses—General cost of formation of company, Government duties, installation of works, experiments and trials, £4,536 17s. 11d.; deduct interest allowed by bankers, £139 16s. 10d.; less bank charges, discount, &c., £74 15s. 9d. = £65 1s. 1d.	4,471	16	10
	£52,747	9	4

The above report was presented to a meeting of shareholders on Wednesday last.

Mr. JAMES ROCK, the chairman of the company, said they had come to the point when they must look matters plainly in the face. Speaking for the board of directors, he would not hesitate to say that they ought to go on with the enterprise if the necessary funds were provided. They had made remarkable progress with their manufactures during the past two or three months, and if the same condition of things had existed a year or two ago, they would not be in the position of being compelled to ask for more money. He claimed for their company that they were quite distinct, and were not mixed up with any other concern. They had gone steadily on their own way, and if they had not actually achieved success, they had established the basis of a good business. He stated at the last general meeting that they had then only recently acquired the patent rights for Germany. Considerable time was taken up in making mandrels, which would enable them to take orders for any size of tube. When they began to take orders they found great difficulty in obtaining copper deposit of the right quality, with the consequence that they had to cease taking orders. After this the funds were run through, and they were now placed in the position of having none whatever. The vendor of the German property had allowed them further time for further instalments. In order to keep the works going, the directors had made themselves personally liable for money for wages, &c., up to the end of next week. They had done their part, but some money must be provided at once, or it will be necessary to close the works. He should ask the meeting to decide if the work was to go on, and to back up this decision by providing funds. They had not run the company into debt, and the total indebtedness was less than £174. They, as

Elmore shareholders, were aware that the mandrel question was a most vital point. It was a troublesome thing at first, for they found when they had deposited copper on the mandrel, the difficulty was to get it off. That was not the only weak point; there must be a special mandrel for every size of tube required. Then there came a very important matter, which had occupied the attention of the board for a considerable time, but which, curiously enough, did not appear to have occurred to the experts. If an order was given for a considerable number of tubes of one diameter, it could not be executed in a reasonable time. As a matter of fact, they were compelled to refuse an order for 14 tubes of one size, because it would have taken 30 weeks to execute. At last the manager of the German works had succeeded in making a mandrel of composition, which when the copper was deposited on was melted by a jet of steam; by this means an order which usually required six months could be executed in five weeks. He claimed that they had improved the process of deposition, which would diminish the cost to a considerable extent. To keep the business going money must be provided at once, and they proposed to raise it by an issue of mortgage debentures on the property of the company. He asked them to subscribe, the money could be exchanged afterwards for other stock; meanwhile they were amply secured on all the property of the company. If they subscribed £1,000 they could go on to the end of this month, and if £2,000 to the end of June. He then moved the adoption of the report and accounts.

General Beadle, a shareholder, then addressed the meeting at considerable length. In his opinion the great blot on the management of the company was going to allotment when only half the capital was subscribed. The original prospectus was unfair and misleading. He commented on the fact that some of the directors of their company were practically vendors as well. In conclusion he moved an amendment that the meeting be adjourned for a month, and a consultative committee to confer with the board of directors.

Another Shareholder then put a long string of questions to the chairman.

The Chairman justified the action of the directors in going to allotment, and said that in his opinion directors of other Elmore companies were the men who were best suited for their company. They had no objection to a consultative committee; in fact they would welcome it. The amendment would practically have the effect of effectually closing the works, and the company would be wound up.

The Solicitor to the company then addressed the meeting as to the effect of the amendment. With a consultative committee the hands of the directors would be completely tied, and they would be unable to raise money.

After further discussion the amendment was put to the meeting and lost.

The Chairman's motion was then carried.

At the close of the meeting, which finished in an informal manner, a conversation took place between the board and the remaining shareholders as to forming a consultative committee, but when our representative left nothing had been decided.

The Brazilian Submarine Telegraph Company, Limited.

The thirty-ninth ordinary general meeting of this company was held on Wednesday last, 3rd inst., at Winchester House, E.C., the Hon. W. St. John Brodrick, M.P., presiding, in the absence of Sir James Anderson through illness.

The Secretary (Mr. Richard Collett) having read the notice convening the meeting,

The Chairman, in moving the adoption of the report and accounts, said he would make a few remarks regarding the company's working, but before doing so would express his great regret at the circumstances which prevented the chairman (Sir James Anderson) being present. Their revenue for the last half-year exceeded that for the preceding half-year by a little over £2,000; that was, however, rather apparent than real, because a certain sum came into the accounts of the last half-year which had been held in suspense in the preceding six months, and would have just altered the balance. Comparing their revenue to December, 1892, with the revenue received in the half-year ending December, 1891, they had a decrease of £13,000; but, on the other hand, they had a decreased expenditure this half-year of something like £5,000, although they had to meet some unusual calls in connection with their staff quarters at St. Vincent. In the previous half-year they had to meet other calls in connection with the duplexing of the cables and repairs, which had not occurred to the same extent in this half-year. He must explain the expenditure at St. Vincent. They had to put on a considerable increase of staff at St. Vincent in consequence of the large amount of business to be transacted on the establishment of a day and night service there. The board, after carefully considering the subject, thought it necessary to create tanks and cable sheds and machinery for keeping spare cable at St. Vincent. Shareholders would be able to appreciate the foresight which dictated this when he announced the repair, that is now completed, in connection with the cable that had broken near Pernambuco. They took the nearest and most easily available ship to repair it. She called at St. Vincent and proceeded direct to the scene of the break, and repaired it on April 28th, and was able to return without even touching in South America, and the economy which had been created by having the cable ready at St. Vincent, so that the ship had not to come to England for it, had been very considerable, and had justified the expenditure they went to at St. Vincent, and which this half-year amounted to £2,000. Since the last meeting other repairs had been executed in No. 1 cable St. Vincent to Pernambuco, and in No. 1 cable, St. Vincent, to Madeira. With regard to the opposition they had had from the South American Cable Company, they were aware this company had been established connecting Senegal with South America, and might be considered to be in opposition to the Brazilian Submarine line. The South American Cable Company opened on October 5th, and operated until December 27th. On December 27th a break occurred in their cables, which were totally interrupted until February 9th. Recently notice had been given by the South American Company of a decrease of rates, to take effect from April 1st. After consulting the Western and Brazilian Company, the board decided to adopt similar rates to the South American Cable Company, and as the object of that company was to take their traffic, the board would, if necessary, continue to reduce rates to be level with the opposition. They had carefully considered the effects of that opposition, and the experience gained of the working did not make the board greatly fear the loss which might be incurred by the competition. There was one subject which was extraneous to the usual business, and that was their proposal to ask the shareholders' leave to establish a fund for pension and superannuation of the employés of the company. The Eastern Company, Eastern and South African, and the Eastern Extension Company, had all adopted superannuation and pension schemes recently on the same basis; their proposal had been, and the directors of this company intended asking the shareholders to do the same, *i.e.*, that the pension fund should be established by a contribution of 2½ per cent. from their salaries by every member of the staff under a certain period of service, and that the company should then add 2½ per cent. to meet that contribution, and they had reason to know that the arrangements so made would be satisfactory to the staff, and would also provide, after many years' service, an adequate pension to those employés. The superannuation scheme was a little different, it had to do with the older members of the staff, who, if they were now put upon a pension scheme, could not by their contributions supply a sufficient amount to provide in any way for their old age. After going into this subject in detail, and stating the particular reasons, both in their interests as a company and in the interests of the staff, why the funds should be established, he stated that the shareholders voted on May 20th, 1881, a sum not to exceed £800 a year towards an insurance fund. They had never exceeded that sum, and that sum in the future would still suffice for the payments towards the superannuation of the older members; for the younger members of the staff they proposed to meet their contribution by a contribution of 2½ per cent. of their own, and that would cost at present about £500. He then moved the adoption of the report and accounts.

The motion was seconded by Sir Daniel Gooch.

Mr. Griffiths (shareholder) complained that the large sum of £35,000 should be put to reserve. Considering the strong position of the company, he thought they might pay that money out in dividends instead.

The Chairman, in reply, said no doubt the reserve fund stood at a high figure, but he would remind Mr. Griffiths that although their No. 1 cable was apparently in a good condition, it was 19 or 20 years old, and they must prepare for its renewal. They had also competition to meet. They had had extra charges in this half-year for renewals. They thought it desirable and prudent to recommend the shareholders to put the sum they had mentioned to the reserve fund.

The motion was then put to the meeting and carried unanimously.

A resolution empowering the directors to act in regard to the pension fund and superannuation schemes was also carried unanimously.

A vote of thanks to the board, and of sympathy with the chairman in his illness, closed the meeting.

The African Trans-Continental Telegraph Company, Limited.

The first ordinary general meeting of the African Trans-Continental Telegraph Company, Limited, was held on Thursday 27th ult., at 19, St. Swithin's Lane, Mr. Albert Gray being in the chair.

The Chairman informed the shareholders that the Duke of Abercorn was unavoidably absent, having been obliged to proceed to Ireland. He went on to say that the meeting would be a purely formal affair but for the fact that, as no articles of association had yet been adopted, it was necessary for the directors whose names were announced on the prospectus to place their resignation in the hands of the shareholders. These gentlemen offered themselves for re-election. A capital of £140,000 had been secured, this being the sum estimated to be necessary for carrying the telegraph as far as Uganda. The material for the first 400 miles had been ordered, and would in a very short time be shipped, one-half going to Chinde Mouth and the other half to Beira for transport to Salisbury, *viâ* the Beira Railway, arrangements having meanwhile been made in South Africa to construct the line from Salisbury as far as Zomba, the British Residency in Nyassaland. Thus the first step had been taken towards the construction of the telegraph which would eventually connect Cape Town and Cairo. By far the greater part of the capital had been supplied by Mr. Rhodes, who had generously undertaken to find such portion of the £140,000 as might not be forthcoming from other quarters by the end of June. Speaking as an individual Englishman, and not as a director of this company, he (the chairman) was jealous for the sake of England that the honour of constructing this Imperial telegraph should belong so exclusively to one Englishman, however distinguished he might be, whose home was in South Africa. He was convinced that there were in this country large numbers of people, both great and small, who would wish to co-operate with Mr. Rhodes in the promotion of this Imperial undertaking.

The resolution for the re-appointment of the retiring directors (the Duke of Abercorn, K.G., and Messrs. C. J. Rhodes, Albert Gray, Rochfort Maguire, S. Neuman, and J. Wernher) was proposed by Mr. Paddon, seconded by Mr. Watkins, and unanimously adopted.

The Yorkshire House-to-House Electricity Company, Limited.

THE report of the directors, to be presented to the ordinary general meeting of the company, to be held at the registered offices of the company, Central Electric Lighting Station, Whitehall Road, Leeds, on Friday, May 12th, 1893, at 3 o'clock in the afternoon, reads as follows:—

"The directors submit herewith a statement of the income and expenditure for the past year, and the balance-sheet showing the assets and liabilities of the company made up to December 31st last. It is intended in future to make up the accounts to December 31st in each year. It will be seen that the balance at credit of the net revenue account is £11 11s. 3d., which amount it is proposed to carry forward. The plant for the first installation of the company's works is now practically completed, and, it is expected, will be in operation at or before the date of the coming general meeting, when the directors hope that a large number of the shareholders will avail themselves of the opportunity of inspecting it. In response to applications from intending consumers, some extensions of mains have been carried out since the last general meeting, and the total length of culverts now laid is about 12,000 yards. In order to meet the urgent requirements of important customers, electricity has been supplied since December 14th last from temporary plant erected on part of the company's spare ground. This supply has been maintained without interruption or irregularity, although the conditions under which it was generated were not so favourable as will be the case in running the permanent plant. The only drawback has been the impossibility of giving the supply to more than a very small proportion of the applicants. The applications for current already received are equivalent to about 10,000 lights. The demand is still growing at a very satisfactory rate, and will, it is anticipated, at an early date, render it desirable to increase the capacity of the company's plant. The retiring directors, Mr. Robert Hudson and Mr. Samuel Ingham, being eligible, offer themselves for re-election. Mr. John Gordon, jun., offers himself for re-election as auditor.

ABSTRACT OF ACCOUNTS to December 31st, 1892.

CAPITAL ACCOUNT.

Dr.	£	s.	d.
Total expenditure to December 31st, 1892	18,993	12	0
To Balance of capital account	10,708	18	0
	£29,702	10	0

Cr.	£	s.	d.
By 100 founders' shares of £5	500	0	0
„ 7,191 ordinary shares of £5 (£3 10s. called up), £25,168 10s.; less calls in arrear, £1,966 ...	23,202	10	0
„ Mortgage	6,000	0	0
	£29,702	10	0

REVENUE ACCOUNT.

Dr.	£	s.	d.
To coals, including dues, carriage, unloading, storing, and all expenses of placing the same on the works, £7 14s. 5d.; to oil, waste, water, and engine-room stores, £3 15s. 9d.; to wages and gratuities, £14 17s. 6d.; to hire of engine for temporary use, £6 9s. 1d.; to rates and taxes, 13s. 10d.; to fire insurance, £1 3s. 5d.	34	14	0
Balance carried to net revenue	70	3	2
	£104	17	2

Cr.	£	s.	d.
By sale of current, £32 9s. 0d.; by rental of meters and other apparatus on consumers' premises, £1 8s. 9d.; by profit on connecting and transformer house account, £3 11s. 5d.; by rents receivable, £67 3s.; by transfer fees, 5s. ...	104	17	2
	£104	17	2

NET REVENUE ACCOUNT.

Dr.	£	s.	d.
To Interest on mortgage...	120	0	0
„ Balance	11	11	3
	£131	11	3

Cr.	£	s.	d.
By Balance brought from revenue account	70	3	2
„ Bank interest	56	4	0
„ Interest on deposit with Leeds Corporation ...	5	4	1
	£131	11	3

GENERAL BALANCE-SHEET.

Dr.	£	s.	d.
To Capital account	29,702	10	0
„ Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, &c., to December 31st, 1892	1,749	0	3
„ Sundry creditors on open accounts	553	14	11
„ Net revenue account—balance at credit thereof ...	11	11	3
	£32,016	16	5

Cr.	£	s.	d.
By Capital account	18,993	12	0
„ Stores on hand at December 31st, 1892	33	16	4
„ Sundry debtors for amounts paid on account of contracts in course of completion	6,433	0	0
„ Preliminary expenses	1,307	17	7
„ Sundry debtors for current supplied to December 31st, 1892	107	9	5
„ By other debtors	6	8	0
„ By deposit with Leeds Corporation and interest accrued due to date	1,005	1	6
„ Cash at bankers	4,125	4	8
„ Cash in hand	4	6	11
	£32,016	16	5

Great Northern Telegraph Company.

AT the general meeting, held at Copenhagen on the 29th ult., Mr. C. F. Tietgen, in rendering an account of the working of the company during the year 1892, said that an alteration had been made with regard to the way of dealing with the profits and expenses of the cable steamers in the accounts. Hitherto the profits accruing from the hire of the cable steamers had been deducted from the expenses, which might give rise to misapprehension, as, in consequence of this deduction, the accounts did not show the amount of the actual expenses. In last year's account, however, this had been put right, and no deduction had been made under the item "Ordinary supervision and maintenance of the sea and land lines and repairing steamers *H. C. Orsted* and *Store Nordiske*," whilst the money earned by the cable steamers had been taken into account under "sundries." This would explain the apparent increase of those two items. Matters called for great circumspection and caution, the more so as the traffic receipts were over £21,000 lower than the previous year. This was partly due to the fact that the reduced rates fixed at the International Telegraph Conference at Paris had been in force the whole of 1892, whilst in 1891 they were in operation during the last six months of the year only; it was also partly due to the continually decreasing rate of exchange of the silver dollar, which affected the company's remittances from the Far East in a very marked manner. These considerations rendered it advisable to place the same amount as last year to the credit of the reserve fund, whilst the board of directors had been enabled to recommend that the total dividend be fixed at the same amount as for the two previous years, viz., 17s. 2d. per £10 share, or about 8·60 per cent.

Western and Brazilian Telegraph Company, Limited.—The directors' report for the half-year ended December 31st, 1892, states that the total earnings for the period amount to £86,954 11s. 2d., against £92,345 4s. 7d. in the corresponding half-year of 1891. Working expenses amount to £37,165 11s. 5d., a decrease of £1,238 13s 8d. compared with the corresponding period of 1891. The directors recommend a dividend of 4s. 6d. per share on the ordinary shares, making a total of £2 10s. per cent. for the year, leaving a balance of £2,830 to be carried forward. We shall print the report next week.

Elmore's French Patent Copper Depositing Company.—A petition for winding up this company was presented on April 26th by the Securities Insurance Company, Limited, and is directed to be heard before the Court on May 17th. Creditors or contributories desirous of opposing or supporting the petition must serve notice to Messrs. Gush, Phillips, Walters and Williams, of 3, Finsbury Circus, by or on May 16th.

Consolidated Telephone Construction and Maintenance Company.—A petition for confirming a resolution reducing the capital of this company from £307,545 to £234,938 was, on April 22nd, presented in the Chancery Division of the High Court of Justice, and is now pending. The list of creditors of the company is to be made out as for June 7th, 1893.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending April 30th, 1893, amounted to £792; week ending May 1st, 1892, £794; decrease £2; total receipts for half-year, 1893, £15,360; corresponding period, 1892, £14,096; increase £1,264.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 28th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, were £3,074.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of April were £3,900; as compared with £3,738 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of April, 1893, amounted to £1,742, against £1,785 in the corresponding period of last year.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation April 27th.	Closing Quotation, May 5th.	Business done during week ended May 5th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101 — 104	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	53 — 54	53 — 54	53½	53
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	94 — 95	94 — 95	95	94
2,876,140*l*	Do. do. Deferred	Stock	13 — 13½	13 — 13½	13½	13⅛
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜ — 12½	11⅜ — 12½	12⅜	12
36,400*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	106 —110	106 —110	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3½ — 3⅝	3½ — 3⅝	3 7/16	3⅜
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2 7/16	...
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	109 —111	109 —111	111	110½
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
630,000*l*	City and South London Railway	Stock	37 — 39	37 — 39	37	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	12⅛ — 12⅜	12⅛ — 12⅜	12 9/16	12⅛
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	10⅛ — 11	10⅛ — 11	10⅛	...
$7,716,000	Commercial Cable, Capital Stock	$100	140 —150	140 — 150	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	3/16 — 5/16	3/16 — 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5¼ — 5⅜	5¼ — 5⅜	5¼	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	12¼	...
6,000	Do. do. 10 p. c. Preference	10	18½ — 19½	18½ — 19½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 12	11⅜ — 12	12	11 11/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15½ — 15½	15⅜ — 15⅝	15½	15⅜
70,000	Do. 6 p. c. Preference	10	16½ — 17	16½ — 17	16⅝	16½
1[illegible]5 900*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	108 —111	...	...
1,294 100*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	114 —117	113 —116 xd	114	113
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅝ — 15⅞	15⅝ — 15⅞	15⅞	15½
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	105	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	113 —116	114 —117	114⅜	...
108,700*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	104	...
146,800*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	101 —104	...	...
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	2½ — 3	2½ — 3	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1/16 — 3/16	1/16 — 3/16	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3/8 — 5/8	⅛ — 3/8	7/16	5/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	⅛ — 3/8	0 — ¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	..	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜ — 10	9⅜ — 10⅛	10	9 15/16
180,042	Do. do. 6 p. c. Preference	10	15½ — 15⅝	15⅝ — 15⅞	15⅝	15½
150,000	Great Northern Tel. Company of Copenhagen	10	19¼ — 19⅜	19 — 19⅛xd	...	...
200,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	106	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6½ — 7½	6½ — 7½	...	..
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10.	22 — 23	23 — 24	23½	22⅝
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	43 — 46	43 — 46	46	44½
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4¼ — 4½	4¼ — 4⅝	4¼	4 1/16
10,000	Do. do. fully paid	5	6 — 6¼	6 — 6¼	6⅛	5⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	..
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½ — 7	6¼ — 6⅞xd	6 11/16	...
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	102 —105	102 —105	103⅛	103⅜
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	5⅛ — 5⅜	5⅛ — 5½	5 7/16	5 5/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	15 — 15½	15 — 15½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14½ — 15	14⅜ — 15⅛	15	14⅝
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5¼ — 5⅜	5⅛ — 5⅜	5⅜	...
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	113 —116	113 —116	115	114⅛
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,451	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛ — ¼	⅛ — ¼	...	...
11,802	Reuter's Limited	8	7 — 8	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7⅜ — 8⅛	7⅜ — 8⅛	8	7 11/16
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7¾ — 8¼	8 — 8⅛	8 5/16	8⅛
3,381	Submarine Cables Trust	Cert.	120 —125	120 —125	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3 — 3½	3 — 3½	3¼	3 1/16
37,350	Telegraph Construction and Maintenance, Limited	12	28 — 30	29 — 31	30	28
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	...	...
58,000	United River Plate Telephone, Limited	5	2⅞ — 3	2 — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ — 6½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	100½	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	98 —102	99 —103	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7¾ — 8¼	7¾ — 8¼	8	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6⅜	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1¾ — 2¼	1¾ — 2¼	...	...
178,[illegible]00*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	...	...
222,700*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	..
88,321	West India and Panama Telegraph, Limited	10	1½ — 1⅝	1½ — 1⅝	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11½ — 12	11½ — 12	11⅞	11¾
4,669	Do do do. 6 p. c. 2nd Preference ...	10	9½ — 10½	9½ — 10½	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	108 —111	108 —111	110½	109½
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125 xd	...	...
169,000*l*	Do. do. 6 p. c. Sterling Bonds	100	101 —104	101 —104	103	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½ — 6	5½ — 6	5⅝	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5½—6.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid), 1⅞—2⅛.—Founders' shares, 200—235.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5, 5—5⅛.—House to House Company (£5 paid) 1⅞—2⅛.—Do. 7 per cent. Preference of £5, 5—5⅛.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6⅛ xd, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6⅛ xd.—Liverpool Electric Supply Shares of £5 (fully paid), 6—6⅛.—Manchester, Edison and Swan Company, 49 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, 6 per cent. £100 Debentures, 101—103.

Bank rate of discount, 3 per cent. (May 4th, 1893).

PROGRESS IN ELECTRIC MEASUREMENT.

THE RECKENZAUN-BINSWANGER METER.

METERS may be divided into two classes, without attempting any elaborate tabulation of the principles which have been utilised in their construction. Considering meters designed to replace the gas meter when electric lighting supplants gas, we have those which (*a*) integrate ampère-hours or watt-hours by absorbing a proportional fraction of the power to be measured, and (*b*) those operating by the action of the current or power in changing the relative position of two or more parts, or accelerating—plus or minus values—the speed of one moving body as compared with another. It would be invidious to press the claims of one class beyond those of the other; in fact, it seems to be recognised that mechanical perfection and instrumental accuracy in proportioning the parts are more important elements towards success than mere electrical principle of action. This assumes that the well-known laws of mechanics are considered with those of electro-dynamics bearing upon a projected design, but of many suggestions, it can be said they are neither better nor worse than their predecessors, and that the question of their obtaining a place in the arena of practical electrical supply work is largely dependent upon the mechanical skill brought to bear upon the concrete realisation of the abstract principle embodied in the instrument.

The preference which exists in the minds of some of our most prominent central station men for one or other of the two meter species to which allusion has been made is, no doubt, of long standing. The greatest care should be taken that such preference is not permitted to exceed a mere engineering opinion of the day upon what has been presented, and to become a prejudice, not only against what has been done on any given line, but also against what may be done in similar directions in the future.

Into the first class of meters fall those of the motor type, indeed all which utilise the measured current or energy as a means of motion giving rotation or displacement to the recording parts. The Hookham, Teague, Forbes, Ferranti, Perry, Elihu Thomson, and others, are examples in which this is the case, while the Schallenberger is to some extent included also. The second division does not possess so many examples, but of those which it does contain a good deal has been seen in practice, and experience of a varied and lengthy nature has been granted to those in touch with this class of work.

Taking the principle that current flowing along a circuit could be integrated into time by causing it to displace a measuring part by an amount either proportional to the quantity to be measured, or in accordance with some definite law, we have the evolution of ideas in the Frager, Kelvin and Scott meters. The suggestion as to alteration of position led to that of alteration of speed; the influence of the current being accelerative, and the changed rate as compared with the standard rate affording a measurement of the current, which, taken over a period of time, would by the increasing difference between the linear or circular space traversed by the accelerated and standard gears, integrate electric quantity.

Early in the eighties, Profs. Ayrton and Perry published the proposal for a meter, based upon the difference in registration of two clocks, one of which was fitted with a magnet in lieu of the ordinary leaden or brass bob weight, the arc of swing taking place over a solenoidal coil, through which circulated the current to be measured. Shortly after this Dr. Aron brought out the meter which is associated with his name, and is exceedingly well known. In this form the registration which represented the measured consumption of electricity was given on a dial, the difference in time between the two clocks being taken mechanically by differential gearing, thus simplifying the use of such a meter, and reducing the necessary calculations which resolved themselves into multiplying the reading by a constant to obtain ampère hours, or assuming constant pressure on the supply mains, units. The Aron meter met with considerable support, and was adopted by several of the existing companies. For alternating currents the maguet was replaced by a fine wire coil, and in the case of energy integrating meters for direct currents, the same arrangement was adopted. In the hands of those who took sufficient interest in the meter question to master not only self apparent facts culled from experience, but also to at least some extent dip into the probable causes of discrepancies and unexpected results, the meters, roughly made and clumsy as at the time they were, achieved a fair success.

One of the best known experts, in whose hands good results have resulted, was Mr. H. W. Miller, the engineer of the Kensington Court Station, and some novel and ingenious adaptations of the meter for special purposes have come from his hands. One of these was a balance meter for charge and discharge of secondary batteries, in which, for a given percentage loss of energy, the meter showed by inspection how much charge was required to replace the discharged current, and thus afforded to the station attendant a simple and yet accurate safeguard as to the regulation of the accumulator. The Aron principle was applied to a torsion clock by Messrs. Oulton and Edmondson, but little has been heard of this meter in practice. The line upon which these inventors worked was not by any means the most promising for development of a meter for the million. The Aron meter found favour in the sight of the committee conducting the Paris trials, and was given first place, being bracketted with a meter designed by Prof. Elihu Thomson, which has since reached this country. The Aron meter tested at the Central Paris Laboratory had an addition to the ordinary type, in that it was fitted with a synchroniser or weight, strung upon a cord connecting the bobs of the two pendulums. Although in the laboratory this device was of value, it does not appear to have been radical enough in its action to remove the objections inherent to the German make of meter.

The correcting attachment represented what had been done in the way of progress till quite recently, when a meter embodying the principle of the accelerated clock gear, but freed from the weaknesses which had made themselves felt in the older patterns, was designed by Mr. Anthony Reckenzaun and Mr. G. Binswanger, and is now under the title of the "General" meter, being handled by the General Electric Company, Limited. The latest thing in any line always creates some stir, and when it has the merit of being fresh, is received with favour on the possibility of its being to some extent a solution of the problem. In this respect the new meter embodies items of construction which strike one as being novel and ingenious. It must be borne in mind that although not a mere modification of the standard pattern of Aron meter, the Reckenzaun-Binswanger has been based upon the lengthy experience with its prototype, and certainly is in appearance more likely to inspire confidence. The replacement of escapement spring clocks by electro gravity synchronised pendulums, the double pendulum, metal case and slate base, but most important of all, the exemption of the clocks from driving any gear and reducing them to simple governors—their proper function—will rank as advances.

The necessity in older types of meter for the clocks to supply the power required by the differential gear militated against their recording with the accuracy which, in principle, the system was capable of attaining. The new meter requires no attention in the way of winding, being driven by current taken from the supply. The cost of maintenance and driving should be small, and as an extremely low current only is used in the driving magnets — somewhere about $\frac{1}{60}$th of an ampère—many of the existing objections raised to the employment of a potential circuit in a meter do not apply to this. The recorded value can be given directly in units, and the adjustments allowed in the design, with this end in view, will be dealt with below. Once having been tested and found correct, there appears to be no necessity for recalibration, and the requirements of the Board of Trade have been borne in mind, as will be seen in the description of the parts. The permanent magnet meter is, of course, restricted in its employment to direct current circuits, but a similar adaptation is in view to render such a meter of use for alternate current work.

Curiously enough, it is the continuous current companies who have experienced most trouble in their meterage arrangements. The Schallenberger meter, which has come to us from the United States, and one or two others, the products of home industry, have given every satisfaction to the alternating systems where they are in use, and the consensus of opinion points to a greater unanimity of opinion between

the supplier and the client as to the value of the electricity consumed than in those instances where the more simple direct supply is in question. The meter of the future is one which will register correctly. It does not necessarily follow that it will be very simple in conception or in actual construction, for supply companies can well afford to pay more for a reliable register of consumption, but both parties will require a fair arbiter.

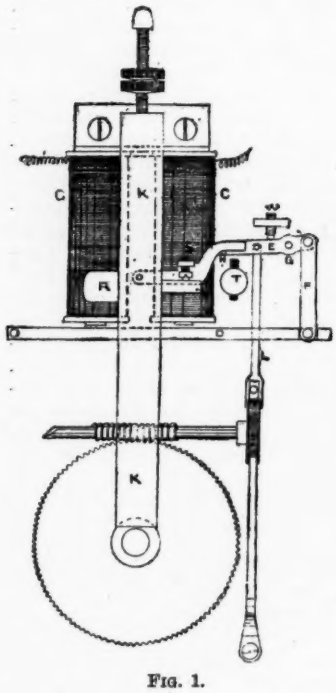


Fig. 1.

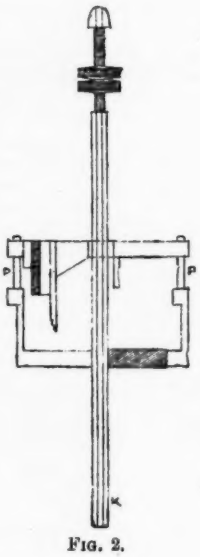


Fig. 2.

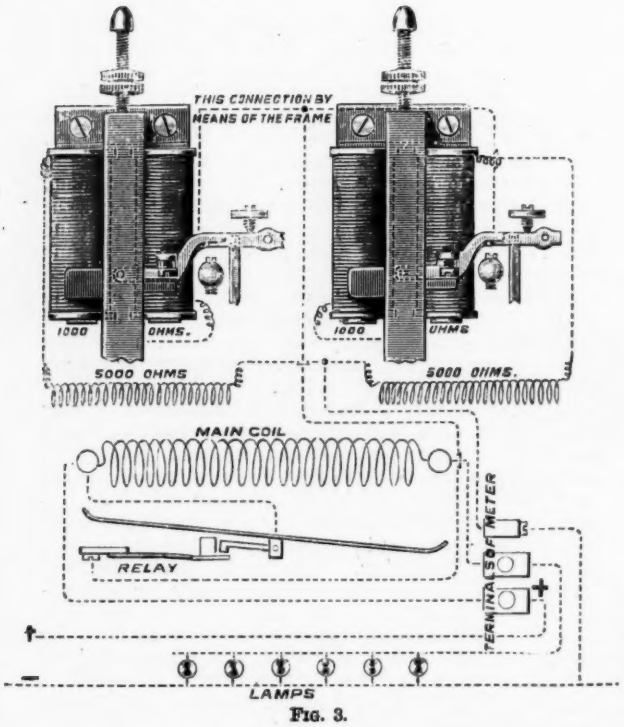


Fig. 3.

To return to the subject of our article. The mechanism in the meter may be considered under three heads; firstly, the standard metronome; secondly, the electrically influenced pendulum and its gear; and, lastly, the recording and indicating apparatus. The electro-magnetic driving apparatus and the pendulum bar of one side of the meter are shown in fig. 1, while the side view of the pendulum is given in fig. 2. Fig. 3 shows the connections of the meter in a circuit, and introduces the relay which closes the driving circuit when the meter is in action. When a current circulates in the main coil owing to a demand on the consumer's premises, the magnetic needle of the relay is deflected, closing the driving circuit and starting the pendulums. As the arrangement of both pendulums is electrically similar, it will only be necessary to trace the course of the current in fig. 1, which represents half of the mechanism, to understand the action of the meter. The bar, K, is insulated from the frame, and is connected to one end of the electro-magnet coil, C. The other end of the coil, C, is taken to the negative side of the lamp circuit, through a resistance of 5,000 ohms, and the

Fig. 4.—Meter with Cover.

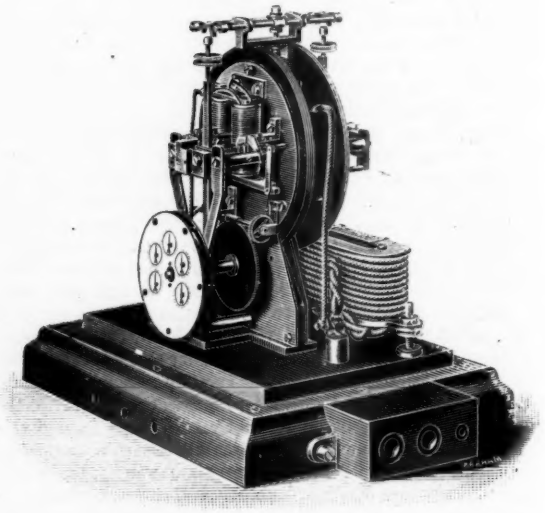


Fig. 5.—Meter Open.

potential terminal on the right hand side of the principal terminals, which is connected to the other side of the circuit by a small well insulated wire. The positive side of the circuit is made through the relay to the frame of the magnets, and thereby the contact screw enables the current to flow to the pendulum bar, thence through the coils and the route described. At the moment the current is turned on, the armature, D, will be attracted, and consequently the pin, H, on the lever, E, will fall, permitting the full weight of the gravity piece, J, to drop upon the cross piece, R, which is a lateral extension of K, and thus the latter is started into vibration. When the end of the gravity piece strikes the stop, T, the driving circuit is broken by R leaving the screw,

S, the armature, D, therefore, immediately falls, and in so doing, resets the pin, H, to its first position, being limited in its upward movement by the stop screw, W. On the pendulum swinging back, the cycle of operations is again repeated, and this continues so long as the relay needle is deflected by current passing through the main coil. The driving power of the metronomic systems is, therefore, obtained by the force of gravity, which acts upon a definite mass free to fall a given distance, and is, therefore, independent of the variation in driving current due to fluctuations in the voltage on the mains. The registration is effected by causing the dependent catch bar, L, to actuate the ratchet wheel shown on fig. 1, so that for every complete swing of the bar, K, a tooth in the wheel is moved forward and the swing registered upon the recording apparatus.

The arbor of one clock being hollow allows the arbor of the other one to be brought through it. The former carries the dials on a frame, the latter a wheel which gears into one on the frame, so that if the two axles revolve together the relative position of a pointer fixed to the wheel carried by the frame, and a point on the dial itself is unaltered. When, however, one axle is given a higher rate than the other, the difference is indicated by a displacement of the pointer and by suitable counting gear the registration of consumption is effected.

Such sparking as might occur with the small current broken periodically at S, has been practically eliminated by a special compound-winding of the magnet coils. The bar, R, and screw, S, are at different radii from centre of vibration of K, so that a rubbing contact is ensured in preference to merely the butt contact which might foul slightly after a period of use under practical conditions. The main coil, through which passes the current to be measured, is a solenoid of special shape and very low resistance. It is placed with its centre below the point of suspension of the magnetic pendulum, whose rate of vibration it accelerates positively by virtually increasing the effect of gravity upon the bar. The relay needle underneath the main coil is deflected by less than the current required by one lamp and so starts the clocks, which cease to register when the current is switched off.

The adjustments are threefold, the first and second being only attempted by the makers, while the third is open to the meter testers of supply companies. For synchronizing the two bars and timing their vibratory beats two nuts are arranged on screwed extensions of the pendulums, while the fine adjustment is given by slight variation in height of contact screw, S. These two means enable meters to be calibrated so as to start registering without difficulty, maintain straight line curves, and read directly in units. If, however, the standards of makers and consumers vary a final adjustment can be made by raising or lowering the main coil, which is mounted on screwed legs with levelling and back nuts for this purpose. No tampering can occur when the meter has been passed for service, as two covers are used, the first covering up the mechanism and being sealed by the local inspector while the second contains the three terminals only, the access to which would be open to the supply company but sealed by them to prevent unauthorised interference. The meter is thus one of the "doubly sealed" type which has been created by the action of the Board of Trade meter regulations.

From some extended practical experience with the Aron meter as used a few years ago, we can readily believe that this meter will comply with the claims of its makers, that it is correct within two per cent. throughout its range, which is stated to be $\frac{3}{4}$ per cent. to 100 per cent. full load.

A locking bar is provided to relieve the pendulum bars during transit, and this is brought into use by a screw so as to avoid shock to the system by sudden jerking.

In appearance the meter is thoroughly English, the case being of japanned metal and fitting air-tight to the base. The parts are mounted on a slate base set within a cast metal frame for strength, while the supporting framework of the parts is utilised as magnetic shields, screening the driving gear of the clocks from one another and from the magnetic pendulum which is given every surrounding possible to ensure accuracy.

The meter question is daily increasing in importance to electricity supply companies. The capital locked up in such apparatus, and its direct bearing upon revenue account, are being felt practically, and no less are consumers, as a class, interested in the means by which their bills are ascertained. This was very evident at Bath recently, and as technical information spreads amongst the middle class, who form the bulk of clients to lighting companies, it is to be expected that nothing but the best meterage appliance will escape criticism.

The confidence of the consumer must be encouraged, and every effort made to meet rational demands on his part for impartial treatment if electricity meters are to be saved from the branding which is, as a matter of course, associated with the gas meter. Considering the care which is and has been taken to procure some degree of accuracy in these appliances, and the close limits—2 per cent. above and 3 per cent. below—within which they must conform to the values to pass the inspector, it seems curious that so much opprobrium should be heaped upon them. Yet it is so, and if the electric meter is to be saved from such a fate it must be the object of much solicitude for years to come.

Without trespassing on controversial grounds, or wounding the susceptibilities of manufacturers, there seems to be a growing record of experience on the meter question which must have great influence in deciding the "fittest" in type which will be the lucky one to "survive."

Meters with electrolytic matter or fluid contacts seem to be burdened with the weight of their own responsibility and prone to diseases purely electrical, from which their more mechanical brethren are exempt. Indeed, the mechanical principle is slowly but surely triumphing all along the line and is, step by step, displacing the very beautiful but less suitable electro-chemical, thermo-electric and purely electro-dynamic arrangements, for the loss of which few beyond the interested parties will feel any sorrow.

NEW PATENTS- 1893.

7,756. "Improvements in the process of obtaining chlorates of the alkalies or of the alkaline earth metals by electrolysis." W. T. GIBBS and S. P. FRANCHOT. Dated April 17th.

7,758. "Improvements in electric fire-alarm apparatus." E. KLOSS. Dated April 17th. (*Complete.*)

7,782. "Improvements in electric cables." G. G. M. HARDINGHAM. (Communicated by Felten & Guilleaume, Germany.) Dated April 17th.

7,806. "Improvements in portable telephones." G. L. ANDERS and W. Köttgen. Dated April 18th.

7,848. "Improved method of indicating telegraphic messages." J. LEVI. Dated April 18th.

7,865. "Lightning arresters and discharge protectors." E. THOMSON. Dated April 18th. (*Complete.*)

7,866. "Lightning arresters." E. THOMSON. Dated April 18th. (*Complete.*)

7,893. "Improvements in junctions for underground conduits for electric wires." J. PATTERSON and J. SHAW & Co. Dated April 19th.

7,897. "Improvements in galvanic batteries for utilising the waste." W. JONES. Dated April 19th.

7,935. "Improvements in arc electric lamps." E. V. BUCHET. Dated April 19th.

7,991. "Improvements in prepayment mechanism, applicable to gas, electricity, and like meters." S. SIMPSON. Dated April 20th.

8,004 "Improvements in or connected with electro-motors, more especially applicable to the propulsion of vehicles." E. DE PASS. (Communicated by M. Johannet and G. Dupont, France.) Dated April 20th.

8,035. "Electro-plating aluminium." H. D. CUNNINGHAM. Dated April 20th.

8,087. "Improvements in arc electric lamps." J. BROCKIE. Dated April 21st.

8,163. "Improvements in miners' electric safety lamps." E. BAILEY and G. M. GORDON. Dated April 22nd.

8,176. "Improvements in electrolytic apparatus." C. HANBURY. Dated April 22nd.

8,177. "Improvements in electrolysis." E. ANDREOLI. Dated April 22nd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

17,160. "Improvements in and relating to electric accumulators." H. H. LAKE. (Communicated from abroad by La Société dite Electriciteits-Maatschappij, of Germany.) Dated October 8th. Consists in filling up the spaces between the ribs of the lead grid

used for the positive electrodes with a mixture of lead peroxide and red lead, and in the employment of finely pulverised metallic lead as a filling material for the negative electrodes. 1 claim.

17,227. "Improvements in electric cables." J. C. HOWELL. Dated October 9th. Consists in covering an electric cable of any suitable construction with a casing of wires or strips of such section that they will interlock and form a metallic flexible tube, which may be covered, if desired, by a bituminous or other suitable coating, according to the position in which the cable is to be laid. 1 claim.

17,324. "Improved method of electric lighting in series and apparatus therefor." G. J. PARFITT and G. J. T. J. PARFITT. Dated October 12th. The inventors arrange the lamps in groups in parallel on the mains, but the lamps in each group they arrange in series, but in a double row, so that the current will divide at the double row half going through each lot of lamps in series and uniting again at the junction on the main. 2 claims.

18,083. "Improvements relating to electrical belts, corsets, and similar articles, and to electrodes therefor." C. B. HARNESS. Dated October 21st. The object of the present invention is to provide for increasing the effect produced by the perspiration from the body upon the plates, electrodes or generators. For this purpose, holes are made through each of the said plates, electrodes or generators, and at the back of the plate, electrode or generator, is placed a piece or disc of thin India-rubber or other suitable material which is impervious to moisture. This material will arrest any moisture emanating from the body of the wearer, and passing through the holes in the said plate, electrode or generator, and will, moreover, condense the moisture contained in the air passing through the said holes from the body of the wearer. 2 claims.

18,524. "Improvements in insulators or insulating supports for electric conductors." W. P. THOMPSON. (A communication by R. Hewitt and F. L. Pope, both of America.) Dated October 27th. The body of this improved insulating support is preferably made of porous material. It may be held in a ring or collar of metal, fixed to a post or other support. A cup or reservoir, situated within or near the body of the insulator, serves to contain a supply of liquid non-conducting material, which is at the same time repellent of moisture, such as resin or paraffin oil. Ducts or channels are provided, either within or without the body of the insulator, from which the said liquid percolates slowly, by capillary attraction, either through the porous substance of the insulator, or through a wick or other like porous or capillary device, flowing therefrom, in a thin continuous film along the external surface, and dripping off at the lower edge, thereby constantly keeping said film renewed with fresh oily material, and carrying away any conducting particles which may have found lodgment thereupon, and maintaining the surface as well as the body of the insulator (when required) in such a condition as to effectually prevent the escape of the electric current to the earth. The reservoir may be replenished with fresh liquid from time to time as its contents becomes exhausted. 3 claims.

18,837. "Improved means for supporting overhead electrical conductors round curves for electric railways or tramways." SIEMENS BROS. and CO., LTD. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated October 31st. Consists in providing on the conductor at curves, lengths of wire attached at each end to the latter, and raised vertically away from the same between such attachments by means of one or more vertical struts, which may be of insulating material, introduced between the two, and the staying wires are then attached to one or more intermediate points of the struts. 1 claim.

18,890. "Improvements in rotary phase current motors and dynamos." SIEMENS BROTHERS & COMPANY, LTD. (Communicated from abroad by Messrs. Siemens & Halske, of Berlin.) Dated November 2nd. Relates to an arrangement whereby a quadrupling of the number of component fields is effected, instead of only a doubling.

19,225. "A polarised electrical indicator." SIEMENS BROS. AND COMPANY, LTD., and A. S. SCHLOEMER. Dated November 6th. Relates to a simple form of polarised indicator which, when acted on by electrical currents transmitted from a distance, presents through a hole in a dial or screen marks distinguished in colour, form or number serving to indicate predetermined signals. 1 claim.

19,952. "Improvements in magnetic separators." W. D. HOFFMAN. Dated November 17th. The machine, to which magnets are adapted, is provided with an endless travelling apron or carrier belt, on to which the crushed ore is delivered at a regulated rate from a fixed hopper fitted with an adjustable shute. This apron, which is furnished with raised edges, is held taut by a pair of drums, one of which is loose on its shaft and closed at its ends, while the other is keyed to its shaft, which is the driver. The shaft of the loose drum is mounted on the main frame of the machine, and the driving shaft, with its drum, is carried by a frame, which is adjustable by screws or otherwise, to maintain the apron at a proper tension. Underlying the apron between the two drums, is a series of magnets consisting of parallel bars of a length equal to the width of the apron, the adjacent bars having opposite polarities. The shaft which carries the loose drum is hollow, and it is closed by a partition at its middle, while on either side of this partition it is pierced with holes. Air, drawn or forced into one end of this shaft, passes out of the holes into the closed drum, and entering the holes on the other side of the partition, passes out from the opposite end of the hollow shaft, and eventually escapes into the atmosphere. The current of air thus made to circulate in the drum, is designed to cool a set of electro-magnets, which are mounted upon the hollow shaft, and occupy the forward half of the internal space of the drum. 9 claims.

22,025. "Improvements in fittings for electric lights." J. SMALLWOOD. Dated December 16th. Consists in fitting any suitable block with a brass or other metal insulator to prevent any leakage of the electric current. 2 claims.

22,640. "Improvements in electric arc lamps." W. B. SAYERS. Dated December 28th. Has reference to a construction of electric arc lamp in which two or more electrodes, preferably of carbon, are arranged side by side with a narrow air space between them, the arc or arcs formed between their adjacent surfaces, when the circuit is completed, being driven to and kept at the free ends of the carbons by a current of air. 4 claims.

22,686. "Improvements in electric forges." E. E. ANGELL. Dated December 29th. The object of this invention is to provide a simple and convenient electric forge for heating bars of metal for forging, hardening, drawing the temper, or other purposes. 7 claims.

22,687. "Improvements in apparatus for heating metals by electricity for forging and tempering." E. E. ANGELL. Dated December 29th. The object of this invention is to provide an electric forge adapted for heating machine tools, picks, axes, and various implements of irregular shapes for the purpose of hardening, forging or drawing the temper. 9 claims.

22,708. "Improvements in the manufacture of porous carbon for galvanic batteries and for filters." W. HELLESEN. Dated December 29th. Claim:—The manufacture of porous carbon for galvanic batteries or for filters by highly heating a mixture of hydrocarbon yielding substances and infusorial earth, with or without the addition of graphite or of animal substances, substantially as hereinbefore described.

CORRESPONDENCE.

Single-Phase Alternating Current Motors.

I do not think that the letter of Mr. Brown in your issue of April 7th, 1893, affects my contention that motors, working on a principle the discovery of which, he had stated, was the result of his own observations, were known in the art. I called attention in my letter to which he refers to my patent, No. 407,844, in support of my assertion. I also stated that I had experimented with various forms of these motors, and I will now be more explicit in relation to them. One of my first motors had the relation of its field coils and armature as 1 : 3; that is to say, the field circuit through which alternating currents were passed, being single, there were three armature circuits closed when running.

Other motors, made in 1889, have numerous armature circuits in relation to the field coils. I tried smooth winding, but always found the projection armatures more effective.

None of these motors were synchronising motors, as Mr. Brown seems to think, but behaved just as he has stated in the words, "only when running light will the speed approach synchronism. When loaded, the speed of the rotating part sinks so far below synchronism, that the current produced by this difference of speed gives the necessary torque. The extent of this drop depends on the form of the rotating part, &c.," when referring to his modification.

In my patent, the statement is made that "many arrangements of coils and cores may be used." Mr. Brown, in his last letter, says, referring to the work of Mr. Tesla and myself, "but I would point out that certain points in their machines were inherently defective, and that it was only by remedying these that I have been able to produce a practical single-phase motor." In other words, as I understand it, Mr. Brown, in 1892, has remedied defects of motors, the principles of which he now admits have been known a long time since. If this be so, then my original contention remains. Further, I submit that the remedies applied are just those which have been applied to all classes of electrical machinery in the past few years—a more intelligent use of iron projections than formerly. I have the greatest admiration for the skill and engineering ability shown by Mr. Brown in his work, but must insist on the identity of principle of his motor and those which preceded it.

In the statement at the close of his letter regarding the high frequencies in vogue in America, and "that there was nothing to prevent the adoption of a lower frequency in the then early stage, &c.," he assumes a familiarity with American conditions in 1888-1889. The statements he makes show conclusively that he does not, and did not, possess this familiarity. The great demand for an alternating single-phase motor in 1888-1889, and even now, is for one which

will go upon the existing lines distributing alternating currents of 125 to 130 frequency. The actual fact was, that in America, up to 1889, these frequencies had been largely introduced, and the desire for uniformity has continued the practice even to the present, when we know much better than we did then what the practical differences in the use of high or low frequencies are. There is now, indeed, a tendency in America to come down to lower frequencies, but it is as yet little more than a tendency. Let us suppose that we had in our possession on sale a few hundred of Mr. Brown's modifications of the single-phase motor here in America, and of all sizes and capacities, and then put the question, Could we sell them to run on existing systems practically, economically, and satisfactorily? and the bearing of the high frequency question, even to-day, in spite of tendencies, will be emphasised in the answer.

Elihu Thomson,
Per J. W. G.

Railway Train Lighting.

My attention has been called to the letter of Mr. W. Langdon, dated the 10th ult., in your issue of the 14th ult., in which that gentleman states he "emphatically accorded to Mr. Houghton, of the Brighton Company, the first place in the application of the electric light to railway travelling."

I have to state that Mr. Houghton simply worked under my patent, which was at the time submitted by me to the Brighton Company.

I therefore call on Mr. Houghton to correct Mr. Langdon, and not to *plume himself with feathers that belong to someone else*. Should he not do so, I will forward to you the late Mr. J. Knight's letters, and Mr. Houghton's letter of the time, addressed to me on the subject, which I think will settle the question very plainly.

J. Evelyn-Liardet.

April 27th, 1893.

The Attractive Properties of a Current.

I wish to draw attention through the medium of your valuable paper to the statement frequently met with in text books, regarding the action of iron filings when a wire carrying a current is brought near them. Prof. S. P. Thompson, in his "Electricity and Magnetism," p. 156, par. 19, says: "Arago found that if a current be passed through a piece of copper wire it becomes capable of attracting iron filings to it so long as the current flows. These filings set themselves at right angles to the wire and cling around it, but drop off when the circuit is broken."

Mr. Perren Maycock, in his "Electric Lighting and Power Distribution," part I., p. 42, par. 37, says: "If the current and therefore the field, be strong, the conductor will pick up iron filings."

Mr. Preece, in his text book of "Telegraphy," in addition to giving a woodcut showing a mass of filings adhering to the wire, on p. 43 says: "If the wire is traversed by a current in the direction shown . . . . it is surrounded along its whole length by a magnetic field; and if it be dipped while in this condition in a mass of iron filings, these filings will, if the current be strong enough, cluster around the wire, and adhere to each other. . . . This is due to the fact that each little piece of iron acquires magnetism and assumes the direction with respect to the wire which its *polarity* (the italics are not mine) imparts to it." In an undated account of a lecture delivered by Prof. Tyndall to a number of science teachers, I see that he gives Arago's experiment as a suitable one for exhibition to their pupils.

It is well known that a wire carrying a current becomes surrounded by a magnetic field; this is indisputable, as is also the fact that if the wire be coiled around a soft iron bar, the bar becomes magnetic. But if any reader of this paper will take the trouble to try Arago's experiment, I think he will have similar results to mine. It seems to me that this experiment has been passed from writer to writer as a "stock experiment!" for I have tried it with 20 and 50 Daniell's cells; also with 50, 60, 80, 100, and 160 bichromate cells in series, with a bare copper wire, and also with a gutta-percha covered copper wire, and could not get a single filing to cluster as stated, yet on the wire being brought into proximity to a P.O. tangent galvanometer, the needle was deflected.

One then begins to wonder how strong a current Messrs. Preece and Maycock had in mind when writing the paragraphs referred to; and I am sure information would be very acceptable.

However, when one remembers that copper is a diamagnetic substance, I think it is at once quite clear that such attraction would not take place.

W. J. Stubbs.

[The writer's failure to obtain the effect is due to the small current used. 160 bichromate cells in *series* would give no more current than one cell, with the low external resistance of a piece of copper wire. A single accumulator cell would show the effect plainly.—EDS. ELEC. REV.]

Influence of the Frequency on the Physiological Effects of Alternating Currents.

Mr. D'Arsonval, in a note to his article of "Influence of the Frequency on the Physiological Effects of Alternating Currents," published in the ELECTRICAL REVIEW for 28th ult., states that I admit that his experiment with a platinum wire, immersed in petroleum oil, proves that it is erroneous to suppose that a filament can be incandesced by high frequency currents of much less ampèrage than would be required if these currents were continuous. I am anxious to point out that I have never said anything of the kind, and that, on the contrary, it appears to me that the deduction that Mr. D'Arsonval draws from his experiment is entirely misleading. According to my view, all measurements of high-frequency currents obtained by observing their heating effect, according to the $C^2 R$ rule, must be incorrect, as, owing to the displacement of the current in the conductor, due to the high rate of alternation, the virtual resistance of the conductor, under these conditions, is much higher than its normal resistance when employed with continuous currents. To my mind, therefore, Mr. D'Arsonval's experiment proves nothing more than that a certain number of watts were expended in his platinum wire. What were the relative amounts of volts and ampères that went to make up these watts, we have no certain means of knowing. There are great difficulties connected with the measurement of the true average voltage of high-frequency currents; but the fact, as I have been able to prove by actual measurement with an electrostatic voltmeter, that the average difference of potential between the ends of the filament of a 100-volt lamp may exceed 500 volts, even when the incandescence produced is considerably below the normal, supports the truth of my contention that the ampèrage of high-frequency current required to incandesce a filament, or heat a wire to a given amount, may be much less than the ampèrage of continuous current required to produce an equal effect on the same filament or wire.

A. A. C. Swinton.

April 28th, 1893.

Relative Safety or Danger of Electric Light Current.

I take the liberty of addressing you for the purpose of eliciting a discussion among electrical experts as to the relative safety or danger of electric light current furnished from stations and used for medical purposes. I am a manufacturer of electro-medical instruments, and as such have refused to furnish any apparatus for the medical use of the electric light current, for the reason that I have considered it dangerous, and liable to cause injury, and even death, to the patient to whom it is applied; and, perhaps, of the doctor who applies it, as well.

I am well aware that the current can be safely used when generated in the building in which it is used, and has no connections with outside electric light wire. The current as generally used, however, I deem dangerous, and for the following reasons: First, that a wire from the arc light or an alternating circuit may cross an incandescent wire; this may readily occur, even in New York City (which I consider the safest city in this country for such use of the current, because the wires are underground; and yet contact may be caused by an explosion, as it has occurred, thus throwing two

wires together, or by a fire in which the wires may be crossed or short-circuited either by water, by iron pipes, or other conductors which may intervene and connect them.

Where aerial wires are employed the danger is greater still, as such wires are liable to cross, as it may be occasioned by a break; trouble may also be anticipated where the trolley system is used.

This question of the safety of the medical current from light wires is of great importance to me, for the reason that if electrical experts are willing to agree as to the safety of such currents, I should not again refuse to make apparatus for that purpose; but I conscientiously feel that no physician has a right to use, and no manufacturer the right to furnish, any remedy or instrument to be used in medicine which is not under complete control, and may prove dangerous, even if there is but one chance in a million that a human life should be sacrificed unnecessarily.

Another question I would propose: in case the patient is maimed or killed, who will be to blame; the doctor, who is supposed to be a scientific man and familiar with all scientific appliances used in the profession, the agent who sells, the manufacturer who makes it, or the electric company who furnishes the current, knowing that it is used for that purpose?

I should be glad to have an expression of opinion upon the points here mentioned, as it is important that it should be thoroughly ventilated and settled, once for all.

Henry E. Waite, M.D.

Notes on Electro-Tanning.

The paper recently read before the Institution of Electrical Engineers by Mr. Falkenstein, and published in your issue of April 14th and 21st, gives some additional proofs to the important part which the electricity takes in the acceleration of the tanning process.

The experiments seem to have been carried out in the laboratory only, on a very small scale, and with a "carefully filtered solution of tannic acid, using platinum electrodes," that is to say, with a tanning liquor and electrodes, which in reality are never used in carrying out the tanning process, and which, therefore, will very materially diminish the practical value of the results thus obtained.

To those who are more closely connected with electro-tanning, it will appear very strange indeed that Mr. Falkenstein should have preferred to carry out his experiments in the manner stated, thereby going over grounds mostly already well known, instead of on a large commercial scale with the very system which he, as electrician to the British Tanning Company, Limited (owners of Worms and Balé drum system), has been working for some years, and which would have enabled him, and, consequently, also, the company, to overturn the current opinion that the said system is not based upon scientific principles, and therefore neither could be, nor has been a commercial success, "although it has been worked on a commercial scale for some years." This is so much more to be regretted, as the company from the very first created a great prejudice in the trade by reason of the way in which it commenced operations, admitting nobody into their works, refusing to give information of any kind, only giving to the outside world, through the medium of the unsuspecting press, in the most superlative terms, the astonishing results said to have been obtained, which alas! never were borne out by the leather actually produced. This prejudice still remains unabated, although since then Dr. Rideal and Mr. Trotter, together with many other scientific experts of unquestionable repute and tanners of recognised standing, after working *on a large commercial scale* with "Groth's system," have proved, without a shadow of doubt, the great importance of the application of electricity to tanning, one of our staple industries, the annual value of which is officially estimated at fully £50,000,000 sterling, nearly two-thirds of which is filled, sad to say, by foreign tannages, although the English tanner has the same advantages and facilities for producing the leather as those who are now inundating us with their products; but, unfortunately, the English tanner does not appreciate scientific advice, and prefers to shut up his tannery rather than to adopt modern means, which would enable him to compete successfully, and thereby to reap for himself the enormous sums which are now lost to him and the country annually entirely by his apparent lack of enterprise.

It seems, therefore, only natural to assume that it should have been in Mr. Falkenstein's own interest to do his utmost to overcome this prejudice by investigating the Worms-Balé process; so much easier for him to do, as every possible facility was at his disposal, and for which he publicly expresses his thanks to the company, by doing which he also makes one believe that his favourable results were obtained from working the Worms-Balé process, which is not the case.

Mr. Falkenstein also says, having referred to the electrical action assisted by mechanical agitation, that besides the Worms-Balé and Groth systems, there are also "others," avoiding to give names or descriptions, from which it may be inferred that he considers them of less or no value; that is, however, not so, because if there are any other systems they would, by being worked, undoubtedly infringe the Worms-Balé or the "Groth's system," as it is not conceivable that the tanning process could be carried out without using either a *movable* receptacle, which is claimed by Worms-Balé, or a *stationary* one, *i.e.*, the ordinary tan-pit, which is claimed by Groth, and for which he has succeeded to obtain exclusive protection in 30 of the most important countries of the world, in spite of the most vigorous oppositions raised thereto by Messrs. Worms and Balé, and which brought forward the well-known actions in the High Court of Justice in England, and the Appeal Court in Germany, resulting in Groth's favour upon all points of issue.

As to the "final result," Mr. Falkenstein continues to say "it has been established by Messrs. Rideal and Trotter, . . . and Dr. Zerener, that a saving of time of from 4 to 38 per cent. is obtained," which would most likely be understood to mean that Messrs. Rideal and Trotter's working would show 4 per cent., and Dr. Zerener's 38 per cent., whilst, in reality, it should be reversed; but even then the figures are wrong, as they ought to be 83 per cent., Messrs. Rideal and Trotter saying in their exhaustive paper: "The average values thus obtained are in the proportion of

Ordinary tannage.	With motion.	With motion and electricity (Groth's patent).
·133	·503	2·08

or the rate of tannage under the influence of electricity and motion (Groth's system) is four times faster than the rate when motion alone is employed, and 16 times faster than when neither are used (ordinary tannage)."

As to the experiments using liquors prepared from different tanning materials, Mr. Falkenstein only refers to three kinds, leaving out such important materials as gambier, valonea, mimosa bark, myrobalans, &c.; if he had investigated these as well, he would have found that all of them offer a different resistance to the electric current, and give a different result in accelerating the tannage by one and the same density of current. Dr. Rideal's remark in *Industries*, "that such tannins, which yield much bloom, should be avoided in electrical work," is not in accordance with practical results obtained, as I am daily using shumac for electro-tanning without the slightest difficulty or loss of tannin, but, as I have always pointed out, "the electric current must be regulated according to the nature of the hides and the composition of the tanning liquor used, in order to obtain satisfactory results."

Finally, judging from the very incomplete way in which Mr. Falkenstein has thought it right to describe the Worms-Balé process, so familiar to himself, by leaving out the most important factor therein, the turpentine, and mentioning those only of far less importance, together with other incorrect statements referred to, and his silence upon the results he unquestionably has obtained during his years of working the Worms-Balé process, which would have been of some interest, even if the practical results obtained should not have been what was desired, I venture to say a doubt will be raised as to how far the other figures given by him are correct and can be relied upon, which is to be regretted, as statements loosely made under the shelter of arrangements so dear to our men of science, will thereby not only create uncertainty, but also cause delay in obtaining that economy in manufacture and quality of product so essential in our days of keen competition, which practice and science combined alone can give.

L. A. Groth, M.R.I.